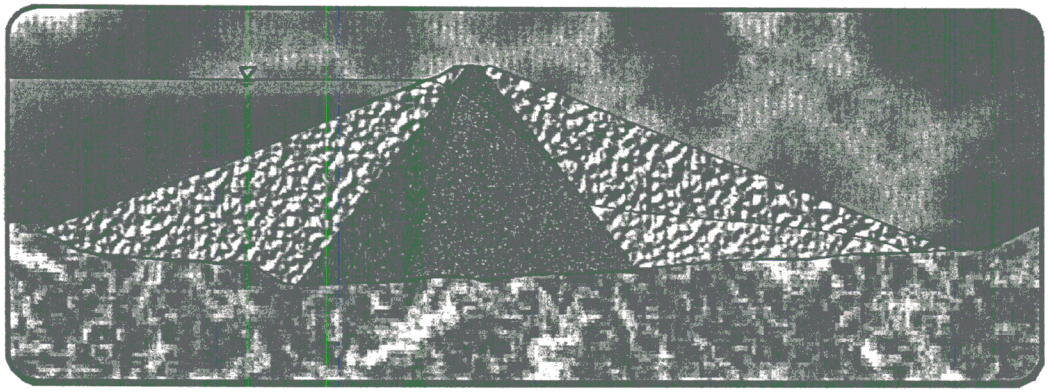
March 2001

SURVEILLANCE REPORT
LEROY ANDERSON DAM NO. 72-9,
Santa Clara County
2000 Summary Report and Analysis



Santa Clara Valley Water District

SURVEILLANCE REPORT
LEROY ANDERSON DAM No. 72-9
Santa Clara County
2000 Summary Report and Analysis

Prepared for:

State of California
Department of Water Resources
Division of Safety of Dams
P.O. Box 942836
Sacramento, CA 95236

Prepared by:

Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118

March 2001

SURVEILLANCE REPORT
LEROY ANDERSON DAM No. 72-9, Santa Clara County
2000 Summary Report and Analysis

Surveillance Reporting Period:

Pneumatic Piezometer and Rainfall Data from January 1993 through December 2000
Dam Crest Monument Data from July 1988 through December 2000
Spillway Training Wall Monument Data from July 1988 through December 2000
Spillway Weir Seepage Data from April 2000 through December 2000

The analysis and interpretation of the instrumentation and other relevant data presented in this report has involved the application of certain graphical and statistical interpretive techniques common to the geosciences and earth dam engineering professions. The conclusions presented in this report were developed upon evaluating the performance of all instruments and other pertinent data during the specified period, and represent the professional judgment of its authors. This report was submitted on March 20, 2001.

Report prepared by:

James L. Nelson, C.E.G.
Associate Engineering Geologist

REGISTERED GEOLOGIST
JAMES LEWIS NELSON
No. 1463
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

Richard L. Volpe, G.E.
Senior Engineer

REGISTERED PROFESSIONAL ENGINEER
RICHARD L. VOLPE
No. 866
Exp. 9-30-01
GEOTECHNICAL
STATE OF CALIFORNIA

TABLE OF CONTENTS

TEXT

Section No. *Title* *Page No.*

1.0 **INTRODUCTION** 1
2.0 **SUMMARY OF FOUNDATION AND EMBANKMENT CONDITIONS** 2
3.0 **PIEZOMETER DATA** 2
4.0 **SPILLWAY UNDERDRAIN FLOW** 3
5.0 **CREST AND SPILLWAY TRAINING WALL MONUMENTS** 4
5.1 Data Collection 4
5.2 Data Presentation 4
5.3 Lateral Displacement 5
5.4 Vertical Displacement 5
5.5 Effects of Earthquakes 5
6.0 **SEISMIC CONSIDERATIONS** 6
7.0 **VISUAL INSPECTIONS** 7
8.0 **FUTURE SURVEILLANCE PLANS** 7
9.0 **CONCLUSIONS** 7
10.0 **REFERENCES CITED** 7

TABLES

Table No.	*Title*	*In Attachments*
1	Pertinent Dam Statistics	
2	January 1993 December 2000 Piezometer and Monthly Rainfall Data (3 sheets)	
3	May 1993 through December 1998 Spillway Underflow Data (3 sheets)	
4	April 2000 through December 2000 Weir No. 1 and No. 2 Seepage Underflow	
5	January 1993 through December 1998 Former Dam Crest Monument Survey X and Y Direction Data, (1 sheet)	
6	January 1993 through December 2000 Dam Crest Monument Survey Vertical, Northings, Eastings and Resultant Vector Displacement Data (3 sheets)	
7	Major Faults and Seismic Considerations (1 sheet)	

TABLE OF CONTENTS (Cont.)

FIGURES

Figure No.	*Title*	*In Attachments*
1	Topographic Map, Leroy Anderson Dam Surveillance Instrumentation	
2	Cross Sections A-A' and B-B', Leroy Anderson Dam Piezometer Locations	
3	Reservoir Water Level, Piezometric Surfaces, and Monthly Rainfall, January 1993 through December 2000	
4	Reservoir Water Level, Historic Spillway Underdrain Flow/New Weir Flow, and Monthly Rainfall, May 1993 through December 2000	
5	Spillway Seepage Weirs	
6	Relative Displacement Vectors of Downstream Crest Monument Lateral Location Surveys, July 1988 through December 2000	
7	Downstream Crest Monument Lateral Location Surveys in Plan View, July 1988 through December 2000	
8	Relative Displacement Vectors of Upstream Crest Monument Lateral Location Surveys, July 1988 through December 2000	
9	Upstream Crest Monument Lateral Location Surveys in Plan View, July 1988 through December 2000	
10	Relative Displacement Vectors of Spillway Training Wall Monument Lateral Location Surveys, July 1988 through December 2000	
11	Spillway Training Wall Monument Lateral Location Surveys in Plan View, July 1988 through December 2000	
12	Downstream Crest Monument Vertical Location Surveys in Section View, July 1988 through December 2000	
13	Upstream Crest Monument Vertical Location Surveys in Section View, July 1988 through December 2000	
14	Spillway Training Wall Monument Vertical Location Surveys in Section View, July 1988 through December 2000	
15	Original Crest Monument Transverse Displacement Versus Time, April 1951 through April 1987	
16	Original Crest Monument Vertical Displacement Versus Time, April 1951 through April 1987	
17	Selected Original Crest Monument Transverse Location Surveys in Plan View, January 1951 through June 1985	
18	Selected Original Crest Monument Vertical Location Surveys in Section View, January 1951 through June 1985	
19	New Crest Monument Easting Displacement Versus Time, January 1993 though December 2000	
20	New Crest Monument Northing Displacement Versus Time, January 1993 through December 2000	
21	Regional Fault Map, Showing Recent Noteworthy Earthquakes Within 50 Miles of Anderson Dam, December 1998 through December 2000	

1.0 INTRODUCTION

This report provides an analysis of recently collected surveillance data from Leroy Anderson Dam, which is owned and operated by the Santa Clara Valley Water District (District). This report is submitted in compliance with the regulations of the California Department of Resources, Division of Safety of Dams (DSOD). The DSOD designation for Leroy Anderson Dam is No. 72-9. Our last surveillance report for Leroy Anderson Dam was submitted to DSOD on January 18, 2000.

During the time period covered by this report, the District monitored 2 pneumatic piezometers in the dam, 2 newly installed seepage monitoring weirs that collect underdrain flow at the spillway, 16 dam crest survey monuments, and 3 spillway training wall survey monuments. The physical locations of instruments discussed herein are shown in plan in Figure 1. Transverse and longitudinal cross sections (Section A-A' and B-B') showing the locations of some of the instrumentation are presented in Figure 2. Two new seepage weirs were installed near the toe of the spillway to measure seepage underflow from the spillway. These new weirs are further discussed in Section 4.0 of this report. No other new instruments were installed during the time period covered by this report.

This report presents tabular and graphical representation of all collected data, our interpretation and evaluation of surveillance data and field observations, and a discussion and interpretation of other matters of interest dealing with our dam surveillance program. The conclusions and assessments regarding the performance and safety of Leroy Anderson Dam presented in this report are based on the professional judgment of its authors.

All crest monument and spillway training wall monument data presented in this report are based on the California Coordinate (Northings and Eastings) system of 1983 North America Datum (NAD). All elevations reported herein are based on the 1988 North American Vertical Datum (NAVD). Table 1 summarizes pertinent dam design data. Table 2 (3 sheets) summarizes January 1993 through December 2000 piezometer and monthly rainfall data. Table 3 (3 sheets) summarizes May 1993 to December 1998 spillway underdrain flow data. In April 2000, the spillway underflow pipes were connected to two new weirs that are located immediately downstream of the spillway on the south side of the spillway. Table 4 presents data from the two new weirs (No. 1 and No. 2) from April 2000 through December 2000. Table 5 summarizes January 1993 through December 1998 former dam crest monument survey X and Y data, and Table 6 summarizes January 1993 through December 2000 dam crest and spillway training wall monument survey vertical, northing, easting, and resultant vector displacement data.

Piezometers are read monthly and the crest monuments are surveyed annually. Seepage at the two spillway underdrain weirs is measured monthly. Reported rainfall is measured at District Rain Gauge No. 41-2073, located a few hundred feet southeast of the left abutment of Leroy Anderson Dam.

2.0 SUMMARY OF FOUNDATION AND EMBANKMENT CONDITIONS

Information in this section is based on Wahler Associates' 1986 Inspection and Safety Review report of Leroy Anderson Dam, prepared in accordance with requirements of the Federal Energy Regulatory Commission, and subsequent reports.

Foundation materials beneath the dam and left abutment are rocks of the Jurassic-Cretaceous Franciscan Complex. Specifically, sandstone and shale underlie the lower right abutment, while the upper right abutment and upstream right abutment are underlain by soft, sheared serpentine. The rocks within the left abutment consist of more competent Franciscan Complex greenstone. The serpentine extends from the upstream toe in the channel and cuts diagonally downstream across the right abutment. A zone of crushed and faulted serpentine characterizes the serpentine/ sandstone contact. Numerous faults mapped within the serpentine appear to be traces of the Coyote Creek fault system.

The dam embankment consists of a wide, central impervious core designated as Zones 2 and 3, flanked by upstream and downstream rockfill shells designated as Zones 1 and 4. The exterior portion of the core has upstream and downstream slopes of 0.75H:1V. A rock drain (see Figure 2) provides control of localized bedrock seepage from the foundation. The minor rock drain was constructed as a strip 20-to-30-foot-wide, about 130 feet long and up to about 20 feet thick on the foundation beneath Zone 3 on the left side of the channel section (i.e., near the maximum section of the dam). The downstream end of the rock drain is connected to free draining rock of the downstream shell (Zone 4). This drain was constructed to control seepage from several springs that were apparently encountered during construction.

3.0 PIEZOMETER DATA

Figure 3 shows piezometric levels, reservoir levels, and monthly rainfall data from January 1993 through December 2000. Both pneumatic piezometers (PPA-1 and PPA-2), originally installed in 1975, show slight fluctuations and response to changes in reservoir levels. As shown in Figure 3, Anderson reservoir began the 2000 calendar year at about el. 603 feet. Winter rains in January (6.0"±) and February (7.0"±) caused the reservoir to nearly fill. On March 16, 2000, the reservoir was at el. 626.7 feet, or 1.1 feet below the spillway lip. This was the maximum reservoir elevation for the year. By mid-October, the reservoir had reached about el. 601 feet and finished the year at about el. 600 feet. This range in reservoir fluctuation has essentially been repeated during the last five calendar years.

In 2000, the piezometric elevation for PPA-1, with its tip at el. 542.8 feet, ranged from 579.1 feet (January 2000) to 586.1 feet (October 2000) with corresponding reservoir levels of 603.1 feet (January 2000) and 601.3 feet (October 2000). At PPA-2, the piezometric elevation ranged from 502.7 feet (January 2000) to 506.4 feet (May 2000) with corresponding reservoir levels of 603.1 feet (January 2000) and 622.2 feet (May 2000). The small change in piezometric

elevation relative to larger reservoir level changes is undoubtedly due to the impervious nature of the core material. There is an indication of a one-to-several month lag time between peak reservoir levels and subsequent piezometric highs.

In referring to Figure 2, it will be noted that PPA-1 is the higher piezometer and that piezometer PPA-2 is located closer to the foundation. Both piezometers are located in Zone 3 core. Assuming that the Zone 1 rockfill shell material is infinitely pervious, it can safely be assumed that full reservoir head acts against the upstream side of Zone 2, which is also part of the core. For the maximum reservoir condition cited above for the March reading, when the reservoir was at el. 626.7 feet, the readings for piezometers PPA-1and PPA-2 represent head losses through the core of 19.5 and 52.3 percent, respectively. This assumes that a reservoir elevation of 626.7 feet represents a total head of 236.7 feet with a datum equal to 390.0 feet, the lowest point in the foundation. Although pneumatic piezometers PPA-1 and PPA-2 show only minor variations in piezometric elevations, these instruments appear to have provided reliable data during the entire surveillance period.

A review of the piezometric data indicates that the embankment and its foundation are performing satisfactorily with respect to pore pressure generation and stability.

4.0 SPILLWAY UNDERDRAIN FLOW

The current seepage-monitoring program for Anderson Dam Spillway was initiated in May 1993. At that time, the District only measured the "center" drainage system which collected seepage from the 1988 extended spillway slabs starting at the D/S toe of the spillway crest and extending left to within 30 feet of the left (looking D/S) training wall and D/S to the spillway bucket. The drainage system was comprised of 4" lateral perforated pipe drains connecting to a longitudinal drain consisting of 6", 8" and 12" perforated pipe, which terminated with a flow meter that measured underdrain discharge (see Figure 1). The flow meter appeared to become pressurized at reservoir levels greater than about Elevation 600 and was known to underestimate the total seepage. The "left side" drainage system (as viewed looking downstream) originally discharged through boulders that were providing slope protection downstream of the spillway bucket and could not be measured. This deficiency was corrected with the weir modification discussed below. The spillway seepage data from the original system is presented on Table 3.

The seepage system was modified during the period from December 1999 through April 2000 with the construction of the two "V" notch seepage weirs to allow for independent and unrestricted measurement of flows. No seepage data were collected during the construction period. Weir No. 1 continues to measure the seepage from the "center" drainage system but is not affected by the restriction and back-pressure as was previously created by the use of a flow meter. Weir No. 2 measures the "left side" seepage starting at the D/S toe of the spillway crest and extending 30 feet to the right of the left training wall and D/S to the spillway bucket. The drainage system is comprised of 4" lateral perforated pipe drains connected to a longitudinal drain consisting of 6", 8" and 12" perforated pipe. The new seepage data for the last nine

months of 2000 are summarized on Table 4.

Figure 4 shows spillway underdrain flow, reservoir levels, and monthly rainfall data from 1993 through 2000, including the "new" weir data beginning in April 2000. Figure 5 is a plot of the individual and combined seepage flow monitored from the two weirs as a function of reservoir level. The former underdrain flow meter appears to have been measuring a total flow of only about 1/2 of the total underdrain flow that is now being measured. As seen in Figure 5, Weir No. 1 represents the preponderance of the total flow below about reservoir elevation 618 feet. Above elevation 618 feet, Weir No. 2 begins to markedly increase in flow rate, whereas the flow rate for Weir No. 1 is only nominally increases. The maximum seepage shown in Figure 5 is about 362 gpm (Table 4) at reservoir elevation 625.8 feet (2.0 feet below the spillway lip). It will be interesting, as more weir data become available, to study the hysteresis of seepage loses. The data shown in Figure 5 is representative of a declining reservoir. We expect the curve to change for an increasing reservoir.

5.0 CREST AND SPILLWAY TRAINING WALL MONUMENTS

5.1 Data Collection

Monument positions are obtained by using conventional terrestrial and GPS surveying techniques. Angles and distances are measured to permanent monuments on top of the dam using a quadrilateral and a long backsight as a basis for monitoring. Elevations of these same monuments are determined using a stable benchmark as a basis. Since installation in 1988, the 19 monuments at Leroy Anderson Dam have been surveyed at least once a year. The data are reported to the nearest 0.01 foot.

5.2 Data Presentation

For the current surveillance period, the monuments were surveyed on December 6, 2000. Plan views of resultant vectors for total movement of downstream crest monuments, upstream crest monuments, and spillway training wall monuments are shown in Figures 6, 8, and 10, respectively. Arrows show total movement since 1988. Figures 6, 8, and 10 can be used as overlays to Figures 7, 9, and 11, respectively, which are plan views of lateral monument displacement. Figures 12 and 13 show vertical displacement of the crest monuments in cross section along the axis of the dam. Figure 14 is a cross section view of the spillway training wall vertical displacement. In this report, "left" and "right" are as perceived by a person looking downstream.

In addition, transverse and vertical displacements of the original dam crest monuments prior to the dam raise in 1988 are shown in Figures 15 and 16, respectively. Transverse locations of the original dam crest monuments are shown in plan view in Figure 17, and their vertical locations are shown in section view in Figure 18. Figure 19 shows the new dam crest monument Easting displacements from January 1993 through December 2000, and Figure 20 shows their Northing

displacements for the same time interval.

5.3 Lateral Displacement

Historically, upstream and downstream crest monuments have been displaced in the upstream direction and are considered to have represented the overall effects of submergence of the upstream shell following first filling of the reservoir. Since 1988, maximum lateral displacement (as indicated by resultant vectors) was 0.3 foot in the downstream direction at Monument 21 (Figure 6). It should be noted that the lateral location survey plots shown on Figures 6 through 11 in this report are slightly different than equivalent plots presented in previous reports from 1995 through 1998. These minor differences are due to changing from the old horizontal datum (NAD 1927) to the new horizontal California Coordinate system (NAD 83) and using GPS survey techniques.

Based on the 1999 data, the general downstream movement of all dam crest monuments appears to have stabilized somewhat since the January 29, 1997 survey. During the period from January 1997 to December 2000, most of the monuments had moved downstream minor amounts; about 0.01 to 0.03 foot (Table 6).

5.4 Vertical Displacement

The crest monuments have exhibited gradual settlement of the embankment since Leroy Anderson Dam was raised in 1988. Maximum settlement of 0.35 foot has occurred at Monument 24 since 1988. Most of this settlement appears to be due to consolidation of the new fill section added when the dam was raised. Only minor amount of settlement (about 0.06 foot) has occurred since May 1996. The dam continues to have adequate freeboard.

5.5 Effects of Earthquakes

A discussion of historic seismicity in the vicinity of Leroy Anderson Dam prior to 1999 is presented in our previous annual reports for the dam (Tepel, January 10, 1997; Tepel, December 31, 1997; Nelson and Khan, March 9, 1999; Nelson and Khan, January 18, 2000). Seismic information was obtained from the U.S. Geological Survey National Strong-Motion Program Internet site (USGS, 2000) and the Northern California Earthquake Data Center Internet site (Northern California Earthquake Data Center, 2000).

In our 1998-1999 annual report (Nelson and Khan, 2000) for Leroy Anderson Dam, we erroneously stated that no noteworthy earthquakes (defined as M_L greater than about 4.0) had occurred within 50 miles of Leroy Anderson Dam during the period from December 1998 to December 1999. In fact, three noteworthy earthquakes occurred in that time period as summarized below and shown in Figure 21.

Earthquakes of about Magnitude 4 or greater during 1999-2000

Event	Earthquake Magnitude	Date	Distance/ Direction from dam
1	4.3	January 18, 1999	SE of Hollister, 41 miles SE
2	3.9	February 4, 1999	4 miles E
3	4.1	March 23, 1999	SE of Hollister, 38 miles SE

For the period from December 1999 to December 2000, there have not been any noteworthy earthquakes or significant earthquakes (defined as M_L greater than or equal to 5.0) within 50 miles of Leroy Anderson Dam.

Because there were no significant earthquakes during the current surveillance period (January 2000 through December 2000) no acceleration data was available from the USGS accelerometers located on the downstream face of Leroy Anderson Dam.

6.0 SEISMIC CONSIDERATIONS

Faults that have the possibility of causing significant ground shaking at the project site are listed in Table 7 and shown in Figure 21, Regional Fault Map. The Working Group on Northern California Earthquake potential (1996) and the CDMG (1996) has identified these faults as capable of producing earthquakes larger than moment magnitude 6 in the vicinity of Leroy Anderson Dam. For each fault we have listed fault length, distance from the dam, historic moment magnitude of the largest earthquake the fault is capable of generating, estimated horizontal peak ground acceleration in the foundation material from such an earthquake, activity level, and estimated effective recurrence time for such an earthquake.

Recent data from the U.S. Geological Survey (Working Group on California Earthquake Probabilities, 1999) indicates there is a 70 percent chance for at least one earthquake of magnitude 6.7 or greater in the San Francisco Bay Area in the next 30 years. Earthquakes of this magnitude could occur on the following faults or fault segments closest to Anderson Dam; the San Gregorio fault, the San Francisco Peninsula segment of the San Andreas fault, the Calaveras fault, the northern and southern portions of the Hayward fault, and the Rodgers Creek fault (Figure 21). The calculated probability of occurrence of a magnitude 6.7 in the next thirty years (2000 to 2030) is 32 % for combined fault slip on the Rodgers Creek and Hayward faults, 21 % on the San Andreas fault, 18 % on the Calaveras fault, 10 % on the San Gregorio fault, 6 % on the Greenville fault, 6 % on the Concord-Green Valley fault, and 4 % on the Mt. Diablo thrust fault, for an aggregate probability of 70 % (Figure 21).

7.0 VISUAL INSPECTIONS

District employees make visual observations during site visits for routine surveillance, operation and maintenance, and other activities. Inspections and observations that were performed during the period of this report include:

- A May 4, 2000, semi-annual inspection of Anderson Dam and appurtenant facilities by DSOD engineer Rich Homna and several District employees.
- A June 13, 2000, inspection of the bedrock channel at the spillway terminus (west end) by District Senior Engineer Dick Volpe, District Field Operations Administrator Ken McKenzie, and District Associate Engineering Geologist Jim Nelson. The purpose of the inspection was to observe existing conditions of the rock and assess possible additional work to divert flow from the left side of the channel. This area was adversely effected by unusually high spillway flows during the winter of 1997. A discussion of the work performed to repair the area effected is summarized in our December 31, 1997 annual surveillance report (Tepel and Nelson, 1997). A more detailed geologic investigation has been suggested and will likely be performed by mid-2001.
- An October 31, 2000, semi-annual inspection of Anderson Dam and appurtenant facilities by DSOD engineer Larry Ford, and several District employees.

8.0 FUTURE SURVEILLANCE PLANS

The District will continue with its current operating procedures and scheduled surveillance plans. Piezometers will be read monthly, crest and spillway training wall monuments will be surveyed annually, and spillway underdrain flows will be measured at the two new weirs at least monthly. In addition, site inspections and monument surveys will be conducted after a significant earthquake or other potentially disruptive activity. The instruments are in good working order, so we do not anticipate replacement or repair works in 2001.

9.0 CONCLUSIONS

Since 1988, current maximum lateral displacement of the crest is about 0.29 foot downstream at Monument 21. The downstream displacement of crest monuments appears to have stabilized since January 1997. Current maximum settlement is 0.35 foot at Monument 24. Review of the surveillance data shows a normal response of the dam to its environment, aging process, and external events. The District will continue with the current monitoring program and will keep DSOD informed of any significant changes pertaining to the surveillance of Leroy Anderson Dam.

10. REFERENCES CITED

Abrahamson, N.A. and Silva, W.J., 1997, Empirical response spectral attenuation relations for shallow crustal earthquakes: in Seismological Society of America, Seismological

Research Letters, Vol. 68, No. 1, January/February 1997, pp. 128-153.
International Conference of Building Officials, 1998, Maps of known active fault near-source zones in California and adjacent portions of Nevada: ICBO, scale 1 in = 4 km.

Northern California Earthquake Data Center (December2000), http://quake.geo.berkeley.edu/cgi-bin/catalog-search.y2K.pl.

Petersen, M., Toppozada, T., Cao, T., Cramer, C., Reichle, M., Maher, M., and Atchison, L., 1998, Determining distances from faults within and bordering the State of California for the 1997 Uniform Building Code: in International Conference of Building Officials 1998, Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada, pp. ix-xvii

Petersen, M.D., Bryant, W.A., Cramer, C.H., Cao, T., and Reichle, M.S., 1996, Probabilistic seismic hazard assessment for the State of California: Department of Conservation Division of Mines and Geology Open File Report 96-08.

Tepel, R.E, January 10, 1997, Leroy Anderson Dam, No. 72-9, Santa Clara County, Interim Summary Report and Analysis of Surveillance Data, Santa Clara Valley Water District unpublished report, 4 p.

Tepel, R.E, December 31, 1997, Leroy Anderson Dam, No. 72-9, Santa Clara County, Annual Summary Report and Analysis of Surveillance Data, Santa Clara Valley Water District unpublished report, 6 p.

Nelson, J.L. and Kahn, M., March 9, 1999, Dam Surveillance Evaluation Report, Leroy Anderson Dam, 1998 Annual Report, Santa Clara Valley Water District unpublished report, 8 p.

Nelson, J.L. and Kahn, M., January 18, 2000, Dam Surveillance Evaluation Report, Leroy Anderson Dam, 1998-1999 Annual Report, Santa Clara Valley Water District unpublished report, 8 p.

United States Geological Survey (December 2000), National Strong-Motion Program, http://agram.wr.usgs.gov.

Volpe, R. L. & Associates, Inc., 1997, 1996 FERC Inspection and Safety Review, Leroy Anderson Dam and Hydroelectric Facility, unpublished consultant§s report on file at the Santa Clara Valley Water District, San Jose, California, 66 p.

Wahler Associates, 1986, Inspection and Safety Review, Leroy Anderson Dam, unpublished consultant's report on file at the Santa Clara Valley Water District, San Jose, California, 42 p.

Wahler Associates, 1991, Safety Inspection of Anderson Dam and Hydroelectric Facility, unpublished consultant's report on file at the Santa Clara Valley Water District, San Jose, California, 44 p.

Working Group on Northern California Earthquake Potential, 1996, Database of potential sources for earthquakes larger than magnitude 6 in Northern California: U.S. Geological Survey Open File Report 96-705, 40 p.

Working Group on California Earthquake Probabilities, 1999, Earthquake probabilities in the San Francisco Bay region: 2000 to 2030 – a summary of findings: California: U.S. Geological Survey Open File Report 99-517, Internet online version 1.0, 36 p.

TABLE 1
Pertinent Dam Statistics (As-built modifications, 1988)
Leroy Anderson Dam

DSOD No.	Year Completed	Type	Dam Height ft	Dam Crest Length ft	Storage Capacity (acre-ft)	Dam Crest Elev. ft	Spillway Crest Elev. ft	Total Freeboard ft
72-9	1950	Rolled Earth & Rock Fill	240	1,385	89,073	646.4-647.4	627.8	~18.5

Note: basis of elevations is NAVD 1988 - values in this table are 2.8 feet higher than those in reports submitted prior to 1998

TABLE 2
January 1993 through December 2000 Piezometer and Monthly Rainfall Data
Leroy Anderson Dam

Date	Reservoir Level (ft)	PPA-1 Piezometric Surface Elevation (ft)	PPA-2 Piezometric Surface Elevation (ft)	Monthly* Rainfall (in)
01/20/93	549.32	552.27	473.61	9.48
02/17/93	592.28	552.96	474.07	6.59
03/17/93	619.85	553.43	477.53	2.36
04/20/93	626.38	553.89	518.19**	0.47
05/19/93	623.35	555.04	481.00	0.67
06/16/93	621.30	555.51	482.61	0.64
07/14/93	620.36	553.89	485.62	0.00
08/18/93	617.65	558.05	486.31	0.00
09/16/93	612.35	558.97	505.48**	0.00
10/28/93	606.05	564.05	491.16	0.43
11/18/93	605.82	562.67	505.48**	1.70
12/20/93	605.52	563.13	493.70	1.50
01/18/94	604.55	567.06	492.78	1.88
02/17/94	604.98	567.98	493.93	4.35
03/23/94	606.28	568.67	494.40	0.55
04/26/94	602.65	569.37	494.63	0.91
05/17/94	598.42	569.37	494.63	1.54
06/22/94	591.82	569.83	494.86	0.00
07/20/94	589.62	567.52	492.32	0.00
08/16/94	587.02	568.67	494.40	0.00
09/19/94	583.48	567.75	491.85	0.00
10/12/94	581.32	569.13	492.55	0.39
11/16/94	574.78	567.75	491.85	2.02
12/15/94	573.85	567.75	490.93	1.50
01/17/95	585.82	565.90	490.01	11.11
02/15/95	609.08	565.44	491.85	0.59
03/15/95	624.22	564.98	492.09	9.09
04/18/95	627.08	568.44	495.32	1.44
05/17/95	627.23	568.21	497.17	0.56
06/14/95	627.09	574.91	499.02	0.48
07/17/95	625.08	576.99	498.32	0.00
08/15/95	622.11	578.84	501.56	0.00
09/19/95	617.58	579.76	501.79	0.00
10/17/95	611.78	579.53	500.63	0.12
11/15/95	607.46	589.46**	499.02	0.00
12/18/95	607.48	577.68	499.94	6.34
01/19/96	606.01	573.99	498.78	3.34
02/16/96	618.44	574.91	498.09	7.57
03/18/96	627.44	575.37	500.17	2.44

TABLE 2
January 1993 through December 2000 Piezometer and Monthly Rainfall Data
Leroy Anderson Dam

Date	Reservoir Level (ft)	PPA-1 Piezometric Surface Elevation (ft)	PPA-2 Piezometric Surface Elevation (ft)	Monthly* Rainfall (in)
04/15/96	627.11	578.14	500.40	0.94
05/20/96	625.93	579.30	501.09	1.69
06/17/96	621.17	578.37	501.56	0.00
07/15/96	616.35	580.45	502.94	0.00
8/19/96	610.63	582.76	502.71	0.00
9/12/96	608.02	579.76	502.25	0.00
10/17/96	602.22	578.61	502.48	1.46
11/19/96	602.06	576.53	500.40	2.39
12/06/96	600.57	576.30	499.02	7.28
01/16/97	626.16	576.53	501.09	11.11
02/18/97	626.68	577.22	502.94	0.08
03/17/97	621.46	578.14	503.64	0.16
04/14/97	621.24	579.99	503.17	0.00
05/15/97	620.00	579.53	501.33	0.16
06/24/97	617.31	576.76	503.87	0.04
07/15/97	614.36	582.76	503.87	0.00
08/18/97	607.17	581.38	503.40	0.08
09/23/97	602.22	579.76	503.64	0.00
10/14/97	599.59	578.37	499.71	0.40
11/19/97	595.15	577.22	500.17	4.22
12/15/97	591.22	575.83	497.63	2.32
01/21/98	596.09	574.91	495.55	6.42
02/17/98	629.14	576.53	500.40	12.05
03/16/98	626.06	577.03	502.02	2.44
04/16/98	627.10	578.84	502.71	1.50
05/18/98	627.00	580.22	501.33	2.36
06/22/98	627.33	582.35	504.91	0.00
07/14/98	625.10	584.38	505.25	0.00
08/17/98	619.80	584.15	505.48	0.00
09/15/98	614.60	583.69	505.48	0.16
10/14/98	611.30	583.23	499.71	0.51
11/17/98	609.80	581.61	504.10	2.73
12/14/98	605.89	580.92	502.02	0.79
1/15/99	604.27	579.76	502.94	3.03
2/17/99	613.06	584.61	bad reading	2.87
3/17/99	617.86	580.68	501.79	2.24
4/15/99	623.66	582.65	501.33	1.69
5/17/99	623.14	584.61	503.40	0.00
6/16/99	622.06	585.19	502.83	0.00

TABLE 2
January 1993 through December 2000 Piezometer and Monthly Rainfall Data
Leroy Anderson Dam

Date	Reservoir Level (ft)	PPA-1 Piezometric Surface Elevation (ft)	PPA-2 Piezometric Surface Elevation (ft)	Monthly* Rainfall (in)
7/14/99	619.90	582.30	503.40	0.00
8/16/99	616.55	577.91	501.33	0.00
9/24/99	610.80	582.19	505.02	0.00
10/20/99	608.04	580.68	504.10	0.04
11/29/99	604.27	580.68	503.87	1.34
12/16/99	603.94	582.76	502.94	0.24
01/12/00	603.08	579.11	502.71	6.26
02/22/00	612.77	579.30	502.48	7.24
03/16/00	626.71	580.45	502.94	1.61
04/18/00	625.82	581.38	481.00**	0.87
05/16/00	622.16	581.15	506.41	0.31
06/15/00	619.90	582.09	504.79	0.31
07/13/00	617.70	582.07	505.25	0.00
08/16/00	611.04	582.76	504.79	0.00
09/13/00	605.90	583.25	505.30	0.04
10/16/00	601.29	586.11	503.64	2.17
11/15/00	602.09	580.34	503.64	0.55
12/05/00	600.25	579.58	501.56	0.28

Notes:
1) basis of elevations is NAVD 1988 - values in this table are 2.8 feet higher than those in reports submitted prior to 1998
2) * = total rainfall at end of indicated month in Date column
3) ** = spurious reading - not shown on Figure 3

TABLE 3
May 1993 through December 1998 Spillway Underdrain Flow Data
Leroy Anderson Dam

Date	Reservoir Level (ft)	Underdrain Flow (gpm)	Date	Reservoir Level (ft)	Underdrain Flow (gpm)	Date	Reservoir Level (ft)	Underdrain Flow (gpm)
05/21/93	623.22	87	06/29/93	620.95	122	10/01/93	609.82	82
05/22/93	623.12	126	06/30/93	620.95	121	10/04/93	609.28	80
05/23/93	623.02	120	07/01/93	620.92	122	10/08/93	608.68	79
05/24/93	622.95	131	07/02/93	620.88	122	10/11/93	608.28	78
05/25/93	622.92	125	07/03/93	620.82	121	10/14/93	607.92	76
05/26/93	622.82	124	07/04/93	620.78	121	10/18/93	607.55	76
05/27/93	622.75	124	07/05/93	620.75	121	10/21/93	607.12	75
05/28/93	622.65	123	07/06/93	620.72	121	10/25/93	606.42	74
05/29/93	622.58	124	07/07/93	620.68	121	10/28/93	606.05	72
05/30/93	622.52	123	07/08/93	620.65	121	02/22/94	605.48	66
05/31/93	622.42	124	07/09/93	620.62	121	02/24/94	605.48	43
06/01/93	622.35	123	07/11/93	620.52	121	02/28/94	606.98	60
06/02/93	622.25	123	07/12/93	620.48	121	03/03/94	607.48	63
06/03/93	622.15	123	07/13/93	620.45	121	03/07/94	606.85	65
06/04/93	622.08	124	07/14/93	620.38	121	03/10/94	606.38	64
06/05/93	622.02	124	07/15/93	620.35	121	03/17/94	606.32	63
06/06/93	621.95	124	07/16/93	620.32	121	03/21/94	606.32	62
06/07/93	621.92	123	07/19/93	620.22	120	03/24/94	606.28	63
06/08/93	621.85	124	07/22/93	620.08	120	03/28/94	606.35	63
06/09/93	621.78	113	07/27/93	619.95	120	03/31/94	606.32	61
06/10/93	621.72	126	07/29/93	619.88	120	04/04/94	606.32	61
06/11/93	621.65	122	08/02/93	619.75	120	04/07/94	606.02	61
06/12/93	621.58	122	08/06/93	619.52	120	04/11/94	605.38	59
06/13/93	621.52	103	08/09/93	619.08	120	04/14/94	604.88	60
06/14/93	621.45	125	08/12/93	618.62	118	04/18/94	604.18	53
06/15/93	621.38	122	08/16/93	617.95	116	04/21/94	603.55	39
06/16/93	621.35	122	08/19/93	617.48	114	04/25/94	602.75	37
06/18/93	621.22	122	08/23/93	616.85	112	04/28/94	602.35	34
06/19/93	621.22	121	08/27/93	616.12	109	05/02/94	601.62	32
06/20/93	621.18	121	08/30/93	615.45	107	05/05/94	601.12	35
06/21/93	621.15	123	09/02/93	614.85	104	05/09/94	600.45	31
06/22/93	621.12	121	09/07/93	613.98	100	05/12/94	599.75	26
06/23/93	621.12	121	09/09/93	613.62	94	05/16/94	598.68	24
06/24/93	621.08	122	09/13/93	612.85	91	05/19/94	598.08	28
06/25/93	621.08	122	09/16/93	612.35	88	05/23/94	597.25	24
06/26/93	621.08	123	09/20/93	611.82	87	05/26/94	596.45	21
06/27/93	621.05	121	09/23/93	611.25	86	05/31/94	594.85	17
06/28/93	621.02	122	09/27/93	610.52	84	06/02/94	594.32	3

TABLE 3
May 1993 through December 1998 Spillway Underdrain Flow Data
Leroy Anderson Dam

Date	Reservoir Level (ft)	Underdrain Flow (gpm)	Date	Reservoir Level (ft)	Underdrain Flow (gpm)	Date	Reservoir Level (ft)	Underdrain Flow (gpm)
06/06/94	593.82	2	09/05/95	619.58	116	06/17/96	621.17	143
06/09/94	593.45	0	09/07/95	619.42	116	06/20/96	620.70	142
06/16/94	592.58	0	09/18/95	617.75	114	06/25/96	619.86	139
06/23/94	591.72	0	09/25/95	616.52	104	06/27/96	619.54	137
03/02/95	609.22	37	09/28/95	616.08	102	07/01/96	618.88	121
03/06/95	609.28	38	10/02/95	615.58	101	07/11/96	617.08	110
03/09/95	609.35	39	10/12/95	613.03	95	07/15/96	616.35	125
03/11/95	615.58	52	10/16/95	612.00	87	07/19/96	615.67	121
05/11/95	626.82	109	10/19/95	611.42	85	07/22/96	615.09	121
05/15/95	627.02	114	10/26/95	610.09	81	07/25/96	614.47	119
05/18/95	627.18	115	10/30/95	609.34	78	07/29/96	613.67	116
05/22/95	627.32	117	11/02/95	608.84	75	08/01/96	613.01	113
05/25/95	627.38	119	11/09/95	607.53	72	08/05/96	612.58	110
05/30/95	627.52	121	11/13/95	607.47	67	08/12/96	611.52	106
06/05/95	627.32	123	11/16/95	607.46	66	08/16/96	611.00	101
06/08/95	627.18	127	11/20/95	607.22	65	08/19/96	610.63	98
06/12/95	626.95	127	11/27/95	607.15	64	08/22/96	610.29	96
06/15/95	627.05	129	12/07/95	609.10	64	08/26/96	609.86	94
06/19/95	626.75	130	12/11/95	607.04	64	08/29/96	609.56	90
06/26/95	626.45	130	12/18/95	607.48	71	09/05/96	608.81	88
06/29/95	626.25	131	12/21/95	606.65	67	09/12/96	608.02	83
07/03/95	626.02	104	12/26/95	605.95	65	09/16/96	607.56	79
07/06/95	625.82	85	12/28/95	605.96	55	09/30/96	606.26	73
07/10/95	625.52	128	01/04/96	606.06	61	10/03/96	605.76	69
07/13/95	625.32	128	01/08/96	605.97	59	10/07/96	604.63	66
07/17/95	625.08	128	01/11/96	605.95	58	10/10/96	603.87	61
07/20/95	624.88	128	01/18/96	605.97	59	10/17/96	602.22	56
07/24/95	624.55	128	01/25/96	606.42	61	10/22/96	601.22	49
07/27/95	624.38	128	02/05/96	614.52	72	10/24/96	601.30	46
07/31/95	624.08	128	05/13/96	626.62	157	10/28/96	601.55	46
08/03/95	623.82	127	5/16/96	626.39	158	11/01/96	601.81	48
08/07/95	623.25	126	5/21/96	625.86	158	11/07/96	602.10	45
08/10/95	622.82	125	5/23/96	625.63	155	11/14/96	602.29	46
08/14/95	622.28	124	5/28/96	624.94	155	11/18/96	602.16	48
08/17/95	621.85	122	06/04/96	623.16	151	11/25/96	601.65	48
08/24/95	620.95	121	06/06/96	622.73	146	12/05/96	600.64	43
08/28/95	620.42	119	06/10/96	622.14	146	12/09/96	600.50	41
08/31/95	620.08	119	06/13/96	621.70	145	12/12/96	601.29	46

TABLE 3
May 1993 through December 1998 Spillway Underdrain Flow Data
Leroy Anderson Dam

Date	Reservoir Level (ft)	Underdrain flow (gpm)	Date	Reservoir Level (ft)	Underdrain flow (gpm)	Date	Reservoir Level (ft)	Underdrain flow (gpm)
12/16/96	601.00	42	10/29/97	598.37	29	07/15/98	624.96	163
12/19/96	600.77	40	11/05/97	597.43	28	07/29/98	623.35	156
12/23/96	602.58	46	11/13/97	596.09	25	08/05/98	622.29	150
12/30/96	603.23	48	11/19/97	595.15	22	08/12/98	620.90	145
01/02/97	611.60	58	12/04/97	592.56	14	08/19/98	619.50	136
06/11/97	618.32	133	12/10/97	591.70	9	08/26/98	618.20	131
06/18/97	617.80	132	12/17/97	590.96	1	09/02/98	616.88	124
06/26/97	617.13	130	03/12/98	626.36	130	09/10/98	615.43	117
07/02/97	616.20	126	03/18/98	625.86	133	09/30/98	612.62	106
07/09/97	615.25	122	03/25/98	627.28	136	10/07/98	611.93	99
07/16/97	614.21	118	04/01/98	627.23	144	10/14/98	611.26	95
08/06/97	610.07	107	04/08/98	626.97	146	10/22/98	610.52	91
08/14/97	608.08	91	04/15/98	627.09	149	10/29/98	609.84	88
08/20/97	606.77	81	04/22/98	627.16	152	11/05/98	610.12	84
08/27/97	605.56	73	04/29/98	627.42	155	11/12/98	610.46	87
09/03/97	604.31	64	05/06/98	627.28	159	11/18/98	609.62	84
09/10/97	603.49	57	05/13/98	627.12	161	12/25/98	608.37	79
09/17/97	603.02	53	05/21/98	626.96	161	12/04/98	607.27	75
09/24/97	602.16	50	05/28/98	627.29	161	12/09/98	606.70	69
10/01/97	601.59	41	06/03/98	627.01	162	12/16/98**	605.81	63
10/08/97	601.02	44	06/10/98	626.96	160			
10/15/97	599.41	40	06/24/98	626.88	162			
10/22/97	598.31	34	35984.00	625.85	166			

Notes: 1) NR = Underdrain flow not recorded
2) ft = feet
3) gpm = gallons per minute
4) basis of reservoir elevations is NAVD 1988 - values in this table are 2.8 feet higher than those in reports submitted prior to 1998
5) ** underdrain flow point replaced with weir - see table 4 for weir data

TABLE 4
April 2000 through December 2000
Spillway Weirs No. 1 and No. 2 Seepage Underflow
Leroy Anderson Dam

Date	Reservoir Level (ft)	Underdrain flow (gpm) Weir No. 1	Weir No. 2	Total flow (gpm)
04/18/00	625.82	220.50	142.00	362.50
05/16/00	622.16	208.00	103.00	311.00
06/15/00	619.90	198.00	70.90	268.90
07/13/00	617.70	168.00	46.20	214.20
08/16/00	611.04	134.00	16.60	150.60
09/13/00	605.90	96.10	9.43	105.53
10/16/00	601.29	65.10	8.08	73.18
11/15/00	602.09	59.70	8.08	67.78
12/05/00	600.25	46.20	6.29	52.49

Notes: 1) Weir No. 1 collects flow from the central portion of spillway
2) Weir No. 2 collects flow from the left side of the spillway

TABLE 5
January 1993 through December 1998 Former Dam Crest
Monument Survey X and Y Direction Data
Leroy Anderson Dam

Date	Monument X Direction Displacement (feet)																		
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1/27/1993	-0.10	-0.03	-0.03	-0.09	-0.12	-0.04	-0.12	-0.03	-0.09	-0.02	-0.07	-0.12	-0.01	-0.06	-0.02	-0.06	-0.05	-0.06	-0.06
1/11/1994	-0.07	-0.06	-0.04	-0.09	-0.13	-0.07	-0.18	-0.09	-0.17	-0.08	-0.12	-0.17	-0.04	-0.09	-0.03	-0.06	-0.04	-0.06	-0.05
12/05/94	-0.05	-0.03	-0.03	-0.09	-0.13	-0.06	-0.17	-0.08	-0.16	-0.07	-0.12	-0.18	-0.04	-0.09	-0.03	-0.07	-0.05	-0.06	-0.06
1/4/96	-0.03	0.01	0.00	-0.09	-0.14	-0.09	-0.22	-0.13	-0.21	-0.12	-0.15	-0.23	-0.06	-0.12	-0.03	-0.08	-0.06	-0.08	-0.07
5/22/96*	NR	NR	NR	-0.10	-0.13	-0.10	-0.24	-0.15	-0.23	-0.12	-0.19	-0.25	-0.09	-0.15	-0.05	-0.10	-0.08	-0.09	-0.07
1/29/1997	NR	-0.02	-0.03	-0.10	-0.15	-0.11	-0.24	-0.16	-0.25	-0.14	-0.20	-0.24	-0.09	-0.14	-0.05	-0.09	-0.07	-0.07	-0.08
12/11/1998	-0.02	-0.03	-0.02	-0.09	-0.18	-0.17	-0.27	-0.19	-0.27	-0.15	-0.19	-0.23	-0.07	-0.11	-0.02	-0.08	-0.05	-0.08	-0.07
12/3/99	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**

Date	Monument Y Direction Displacement (feet)																		
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1/27/1993	-0.07	-0.07	-0.06	-0.06	-0.07	-0.10	-0.06	-0.10	-0.05	-0.05	-0.01	0.00	-0.02	-0.01	-0.03	-0.03	-0.05	-0.04	-0.06
1/11/1994	-0.08	-0.05	-0.04	-0.06	-0.07	-0.10	-0.06	-0.09	-0.02	-0.04	0.00	0.01	0.01	-0.01	-0.01	-0.04	-0.03	-0.03	-0.05
12/05/94	-0.09	-0.07	-0.07	-0.06	-0.07	-0.10	-0.06	-0.10	-0.05	-0.06	0.00	0.01	-0.01	-0.01	-0.01	-0.04	-0.04	-0.04	-0.05
1/4/96	-0.07	-0.09	-0.04	-0.06	-0.08	-0.11	-0.06	-0.11	-0.04	-0.06	0.00	0.02	0.00	-0.01	-0.02	-0.04	-0.06	-0.05	-0.06
5/22/96*	NR	NR	NR	-0.05	-0.04	-0.06	-0.02	-0.05	0.01	-0.01	0.02	0.02	-0.01	-0.03	-0.04	-0.06	-0.06	-0.06	-0.07
1/29/1997	NR	-0.05	-0.04	-0.04	-0.05	-0.07	-0.03	-0.06	0.00	-0.02	0.03	0.03	0.01	0.00	-0.02	-0.03	-0.03	-0.04	-0.05
12/11/1998	-0.07	-0.05	-0.08	-0.06	-0.06	-0.07	-0.05	-0.06	-0.01	-0.03	-0.01	0.01	-0.03	-0.04	-0.06	-0.08	-0.08	-0.08	-0.10
12/3/99	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**

Notes:

1) Y direction displacement represents longitudinal movement
2) Negative X direction displacement represents downstream movement
3) Positive X direction displacement represents upstream movement
4) NR = monument survey data not recorded
5) Displacement is net movement since 1988
6) * = special monument survey after May 21, 1996 earthquake
7) ** = X and Y survey lines no longer monitored - new system uses Northings and Eastings survey data (see Table 6)

TABLE 6
January 1993 through December 2000 Dam Crest Monument Survey
Vertical, Northings, Eastings and Resultant Vector Displacement Data
Leroy Anderson Dam

Date	Monument Vertical Displacement (feet)																		
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1/27/1993	0.01	-0.03	-0.03	-0.01	-0.09	-0.11	-0.27	-0.21	-0.32	-0.26	-0.23	-0.35	-0.18	-0.16	-0.09	-0.05	-0.04	-0.04	-0.06
1/11/1994	-0.02	-0.01	-0.01	0.01	-0.08	-0.07	-0.24	-0.18	-0.29	-0.25	-0.22	-0.35	-0.20	-0.16	-0.11	-0.06	-0.04	-0.03	-0.05
12/5/1994	NR	NR	NR	0.02	-0.06	-0.06	-0.23	-0.17	-0.29	-0.24	-0.18	-0.30	-0.14	-0.13	-0.06	-0.02	0.00	0.02	NR
1/4/1996	NR	NR	NR	-0.05	-0.12	-0.11	-0.25	-0.18	-0.30	-0.25	-0.19	-0.31	-0.14	-0.13	-0.07	-0.04	-0.03	-0.02	-0.01
5/22/1996*	NR	NR	NR	0.01	-0.06	-0.04	-0.20	-0.15	-0.27	-0.24	-0.18	-0.30	-0.13	-0.12	-0.05	-0.01	-0.01	0.01	-0.01
1/29/1997	NR	-0.08	-0.03	0.02	-0.05	-0.06	-0.26	-0.19	-0.34	-0.30	-0.22	-0.37	-0.18	-0.17	-0.10	-0.08	-0.03	-0.01	-0.02
12/11/1998	0.00	-0.02	-0.01	0.01	-0.08	-0.07	-0.25	-0.19	-0.33	-0.28	-0.22	-0.34	-0.17	-0.15	-0.08	-0.04	-0.02	0.00	-0.01
12/3/1999	0.00	-0.01	0.00	0.01	-0.07	-0.07	-0.25	-0.19	-0.32	-0.28	-0.21	-0.35	-0.17	-0.14	-0.08	-0.03	-0.01	0.01	-0.01
12/6/2000	0.01	-0.01	0.00	0.02	-0.07	-0.07	-0.26	-0.19	-0.33	-0.28	-0.23	-0.35	-0.18	-0.15	-0.08	-0.03	-0.02	0.00	0.00

Date	Monument Northings Displacement (feet)																		
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1/27/1993	-0.10	-0.04	-0.04	-0.08	-0.11	-0.07	-0.11	-0.07	-0.07	-0.02	-0.03	-0.06	0.01	-0.03	0.00	-0.04	-0.05	-0.05	-0.06
1/11/1994	-0.08	-0.06	-0.04	-0.08	-0.11	-0.10	-0.15	-0.10	-0.12	-0.06	-0.07	-0.10	-0.01	-0.07	-0.02	-0.07	-0.05	-0.06	-0.07
12/5/1994	-0.08	-0.05	-0.05	-0.08	-0.11	-0.09	-0.15	-0.11	-0.13	-0.06	-0.07	-0.10	-0.02	-0.07	-0.02	-0.07	-0.05	-0.07	-0.08
1/4/1996	-0.05	-0.03	-0.02	-0.08	-0.14	-0.12	-0.19	-0.14	-0.16	-0.10	-0.10	-0.13	-0.02	-0.09	-0.03	-0.09	-0.07	-0.09	-0.10
5/22/1996*	NR	NR	NR	-0.08	-0.09	-0.09	-0.17	-0.13	-0.15	-0.08	-0.11	-0.16	-0.06	-0.12	-0.06	-0.10	-0.09	-0.10	-0.10
1/29/1997	NR	-0.05	-0.05	-0.10	-0.14	-0.13	-0.20	-0.16	-0.19	-0.11	-0.11	-0.15	-0.04	-0.09	-0.04	-0.07	-0.06	-0.07	-0.08
12/11/1998	-0.05	-0.05	-0.06	-0.10	-0.16	-0.16	-0.22	-0.18	-0.20	-0.12	-0.13	-0.16	-0.05	-0.10	-0.04	-0.09	-0.07	-0.09	-0.10
12/3/1999	-0.07	-0.04	-0.04	-0.10	-0.15	-0.13	-0.21	-0.16	-0.20	-0.11	-0.13	-0.16	-0.05	-0.10	-0.05	-0.10	-0.08	-0.09	-0.10
12/6/2000	-0.04	-0.03	-0.01	-0.05	-0.09	-0.08	-0.16	-0.12	-0.15	-0.06	-0.09	-0.11	-0.01	-0.06	0.00	-0.05	-0.04	-0.06	-0.07

TABLE 6
January 1993 through December 2000 Dam Crest Monument Survey
Vertical, Northings, Eastings and Resultant Vector Displacement Data
Leroy Anderson Dam

Date	Monument Eastings Displacement (feet)																		
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1/27/1993	-0.01	0.05	0.02	0.00	-0.02	0.06	-0.01	0.06	-0.02	0.03	-0.04	-0.08	0.01	-0.02	0.02	-0.01	0.00	0.00	0.02
1/11/1994	0.03	0.02	0.00	0.00	-0.02	0.04	-0.06	0.02	-0.09	-0.02	-0.08	-0.12	-0.03	-0.04	-0.01	-0.01	0.00	-0.01	0.01
12/5/1994	0.05	0.05	0.03	0.00	-0.02	0.04	-0.05	0.03	-0.07	0.00	-0.08	-0.12	-0.01	-0.05	-0.01	-0.02	0.00	0.00	0.00
1/4/1996	0.06	0.09	0.04	0.00	-0.02	0.04	-0.07	0.00	-0.11	-0.03	-0.11	-0.15	-0.03	-0.07	0.00	-0.02	0.00	0.00	0.01
5/22/1996*	NR	NR	NR	0.00	-0.03	0.01	-0.11	-0.04	-0.14	-0.06	-0.13	-0.17	-0.04	-0.06	0.00	-0.02	-0.01	-0.01	0.01
1/29/1997	NR	0.00	-0.04	-0.07	-0.10	-0.05	-0.15	-0.09	-0.20	-0.10	-0.18	-0.21	-0.09	-0.11	-0.04	-0.05	-0.04	-0.04	-0.02
12/11/1998	-0.02	-0.03	-0.02	-0.07	-0.11	-0.09	-0.17	-0.11	-0.21	-0.11	-0.19	-0.24	-0.10	-0.12	-0.04	-0.06	-0.05	-0.06	-0.04
12/3/1999	-0.03	0.00	-0.03	-0.07	-0.10	-0.05	-0.16	-0.09	-0.21	-0.11	-0.20	-0.23	-0.11	-0.13	-0.04	-0.07	-0.05	-0.06	-0.04
12/6/2000	-0.03	-0.03	-0.06	-0.09	-0.12	-0.06	-0.18	-0.12	-0.23	-0.15	-0.25	-0.28	-0.15	-0.17	-0.09	-0.11	-0.09	-0.10	-0.09

Date	Monument Resultant Vector Displacement (feet)																		
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1/27/1993	0.10	0.06	0.04	0.08	0.11	0.09	0.11	0.09	0.07	0.04	0.05	0.10	0.01	0.04	0.02	0.04	0.05	0.05	0.06
1/11/1994	0.08	0.06	0.04	0.08	0.11	0.11	0.16	0.10	0.15	0.06	0.11	0.16	0.04	0.08	0.02	0.07	0.05	0.06	0.07
12/5/1994	0.09	0.07	0.06	0.08	0.11	0.10	0.16	0.11	0.15	0.06	0.11	0.16	0.02	0.09	0.02	0.07	0.05	0.07	0.08
1/4/1996	0.08	0.09	0.04	0.08	0.14	0.13	0.20	0.14	0.19	0.10	0.15	0.20	0.04	0.11	0.03	0.09	0.07	0.09	0.10
5/22/1996*	NR	NR	NR	0.08	0.09	0.09	0.20	0.14	0.20	0.10	0.17	0.23	0.07	0.13	0.06	0.10	0.09	0.10	0.10
1/29/1997	NR	0.05	0.06	0.12	0.17	0.14	0.25	0.18	0.28	0.15	0.21	0.26	0.10	0.14	0.06	0.09	0.07	0.08	0.08
12/11/1998	0.05	0.06	0.06	0.12	0.19	0.18	0.28	0.21	0.29	0.16	0.23	0.29	0.11	0.16	0.06	0.11	0.09	0.11	0.11
12/3/1999	0.08	0.04	0.05	0.12	0.18	0.14	0.26	0.18	0.29	0.16	0.24	0.29	0.12	0.16	0.06	0.12	0.09	0.11	0.11
12/6/2000	0.05	0.04	0.06	0.11	0.15	0.11	0.24	0.17	0.27	0.16	0.26	0.30	0.15	0.18	0.09	0.12	0.10	0.12	0.12

TABLE 6
January 1993 through December 2000 Dam Crest Monument Survey
Vertical, Northings, Eastings and Resultant Vector Displacement Data
Leroy Anderson Dam

Notes:

1) Negative vertical displacement represents settlement
2) Positive vertical displacement represents heave
3) Negative Northing displacement represents southern movement
4) Postive Northing displacement represents northern movement
5) Negative Easting displacement represents western movement
6) Positive Easting displacement represents eastern movement
7) NR = monument survey data not recorded
8) Displacement is net movement since 1988
9) * = special monument survey after May 21, 1996 earthquake
10) Resultant vectors calculated by vector addition of Northings & Eastings

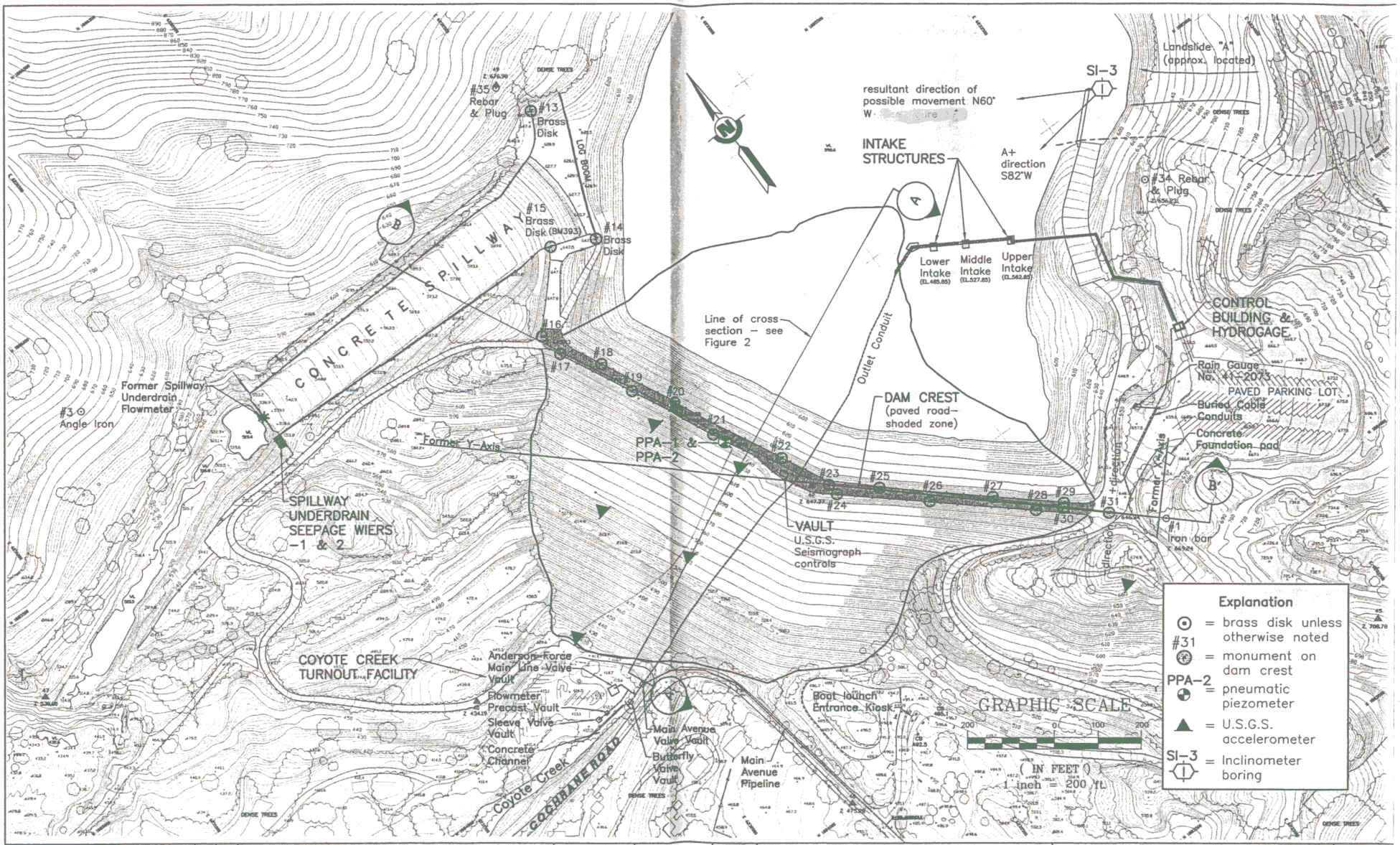
TABLE 7

Major Faults and Seismic Considerations – Anderson Dam (No. 72-9)

Fault name & Fault type	Length km (miles)	Distance & direction from site km (miles)	Historic* Moment Peak Magnitude (M_w)	Estimated** Peak Ground Acceleration (g)	Effective Recurrence Interval, yr
Southern Calaveras (RL)	106 (66)	2 (1) to NE	6.2	0.57	***330
Hayward, Southeast Ext (R & RL)	26 (16)	14 (9) to NW	6.4	0.26	220
Sargent (R) & (RL)	53 (33)	16 (10) to SW	6.8	0.26	1,200
Monte Vista-Shannon (R)	41 (25)	19 (12) to NW	6.8	0.25	2,410
San Andreas 1906 rupture (RL)	470 (292)	21 (13) to SW	7.9	0.27	210
San Andreas SC Mts (RL)	37 (23)	21 (13) to SW	7.0	0.19	400
Zayante-Vergeles (R & RL)	56 (35)	26 (16) to SW	6.8	0.16	8,821
Greenville (RL)	73 (45)	30 (19) to NE	6.9	0.13	521
San Andreas Peninsula (RL)	88 (54)	33 (21) to W-NW	7.1	0.13	400
Ortigalita (RL)	66 (41)	33 (21) to NE	6.9	0.12	1,153
Quien Sabe (RL)	22 (14)	35 (22) to SE	6.4	0.09	647
Hayward South (RL)	43 (27)	35 (22) to NW	6.9	0.11	167
Northern Calaveras (RL)	52 (32)	35 (22) to NW	6.8	0.10	146
Great Valley 8 (R)	41 (25)	50 (31) to NE	6.6	0.08	483
Monterey Bay - Tularcitos (R & RL)	83 (52)	51 (32) to SW	7.1	0.09	2,600
Great Valley 7 (R)	45 (28)	52 (32) to NE	6.7	0.08	622
Rinconada (RL)	190 (118)	55 (34) to S-SW	7.3	0.08	1,764
San Gregorio (R & RL)	129 (80)	56 (35) to SW	7.3	0.10	400
Great Valley 9 (R)	39 (24)	57 (36) to E-SE	6.6	0.07	508
Great Valley 6 (R)	45 (28)	62 (39) N	6.7	0.07	622
San Gregorio – Sur (RL)	79 (49)	62 (38) to SW	7.0	0.06	411
Hayward North (RL)	43 (27)	77 (48) to NW	6.9	0.05	167

Notes:

1) * Maximum moment magnitude calculated from relationships (rupture area) derived by Well and Coppersmith (1944). Values taken from Working Group on Northern California Earthquake Potential, 1996 and Probabilistic Seismic Hazard Assessment for the State of California, 1996, CDMG Open-File Report 96-08.
2) Distances to faults based on CDMG digitized fault location database using Thomas F. Blake software EQFAULT 1996.
3) ** The estimated peak ground acceleration value is based on an earthquake attenuation relationship by Abrahamson and Silva (1995).
4) *** Estimated by SCVWD
5) (RL) = right lateral strike slip fault, (R) = reverse fault (File: W:\geology\nelson\dsod\anderson\tables\faulttb)



REV	DESCRIPTION	DATE	APPR

REFERENCE INFORMATION AND NOTES

1) THIS MAP IS A COMPILATION OF AERIAL MAPPING, SURVEY FIELD DATA AND DIGITIZED CONSTRUCTION MAPS. IN OPEN, UNOBSTRUCTED AREAS THIS MAP COMPLIES WITH NATIONAL STANDARDS FOR MAP ACCURACY. IN AREAS OF DENSE VEGETATION WHERE THE GROUND IS OBSCURED FROM VIEW, CONTOURS MAY DEVIATE FROM CORRECT ELEVATION. MAXIMUM DIGITIZED ERROR COULD BE± ONE FOOT VERTICAL AND HORIZONTAL.
2) GRID IS BASED ON CALIFORNIA COORDINATE SYSTEM, ZONE III, NAD 83.
3) ELEVATIONS BASED ON N.G.S. VERTICAL DATUM, NAVD 88. THE DE BETWEEN NAVD 29 AND NGVD 88 IS 2.80 FT.
4) PHOTOGRAMMETRIC MAPPING BY AERO–GEODETIC CORP. PHOTO DATE: 12/11/97
5) S.C.V.W.D. SURVEY FOLDER #18 and #20

DATE	02/20/01
DESIGN	JLN
DRAWN	BLS
CHECKED	RV

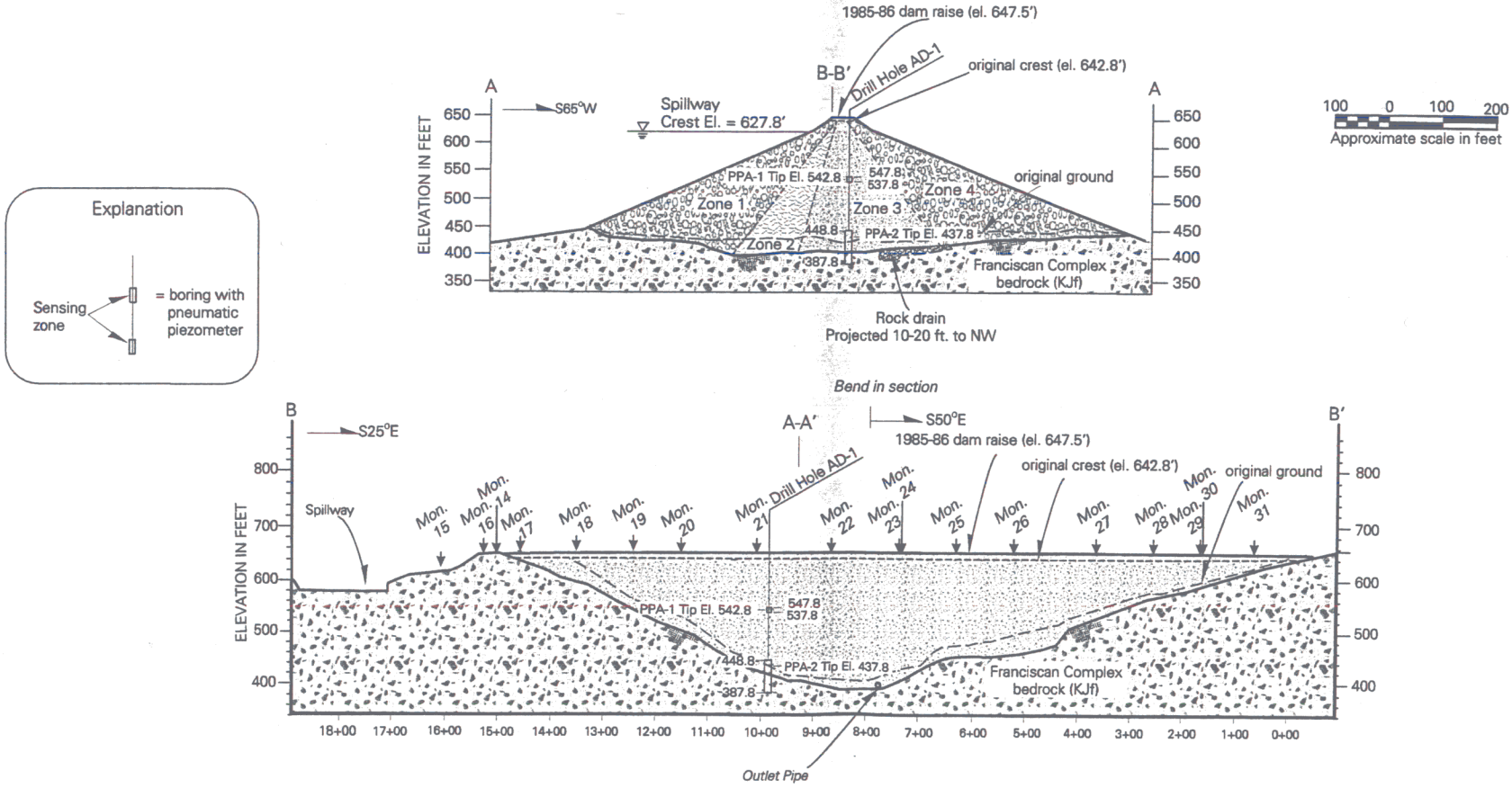
Santa Clara Valley Water District

TOPOGRAPHIC MAP

Leroy Anderson Dam (No.72–9) Surveillance Instrumentation

SCALE 1" = 200'

FIGURE 1



Note: 1) basis of elevation is NAVD 1988 - elevations on this section are 2.8 feet higher than those dated earlier than 1998
2) file: W:/geology/nelson/dsod/anderson/figures/cdr/annewf2.cdr

DATE	12/02/00
DESIGN	JLN
DRAWN	JLN
CHECKED	RLV

Santa Clara Valley Water District

Cross Sections A-A' & B-B'

Leroy Anderson Dam (No. 72-9)

Piezometer Locations

SCALE 1" = 200'

FIGURE 2

LEROY ANDERSON DAM (No. 72-9)

Santa Clara Valley Water District

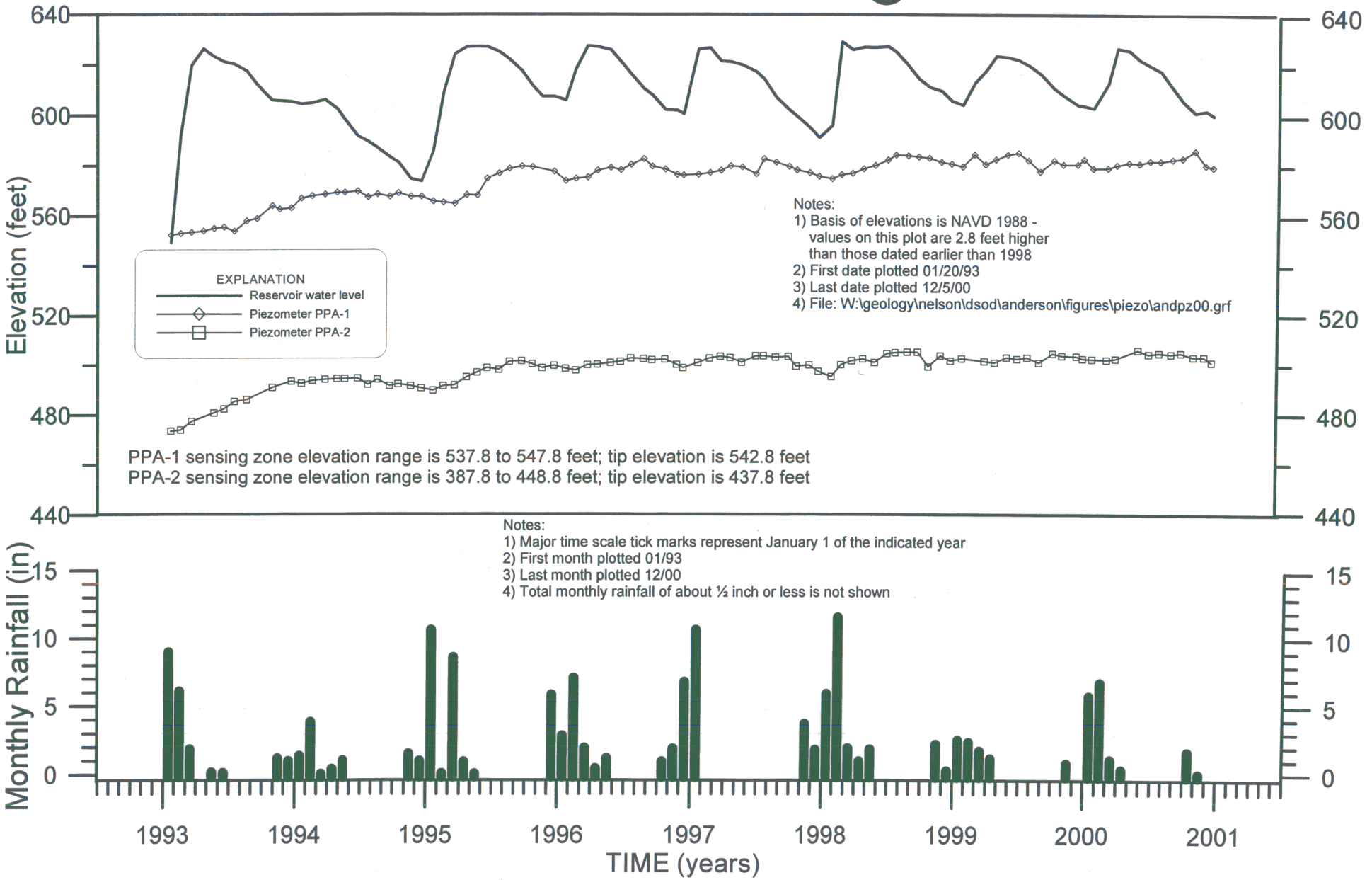


Figure 3. Reservoir Water Level, Piezometric Surfaces, and Monthly Rainfall, January 1993 through December 2000

LEROY ANDERSON DAM (No. 72-9)

Santa Clara Valley Water District

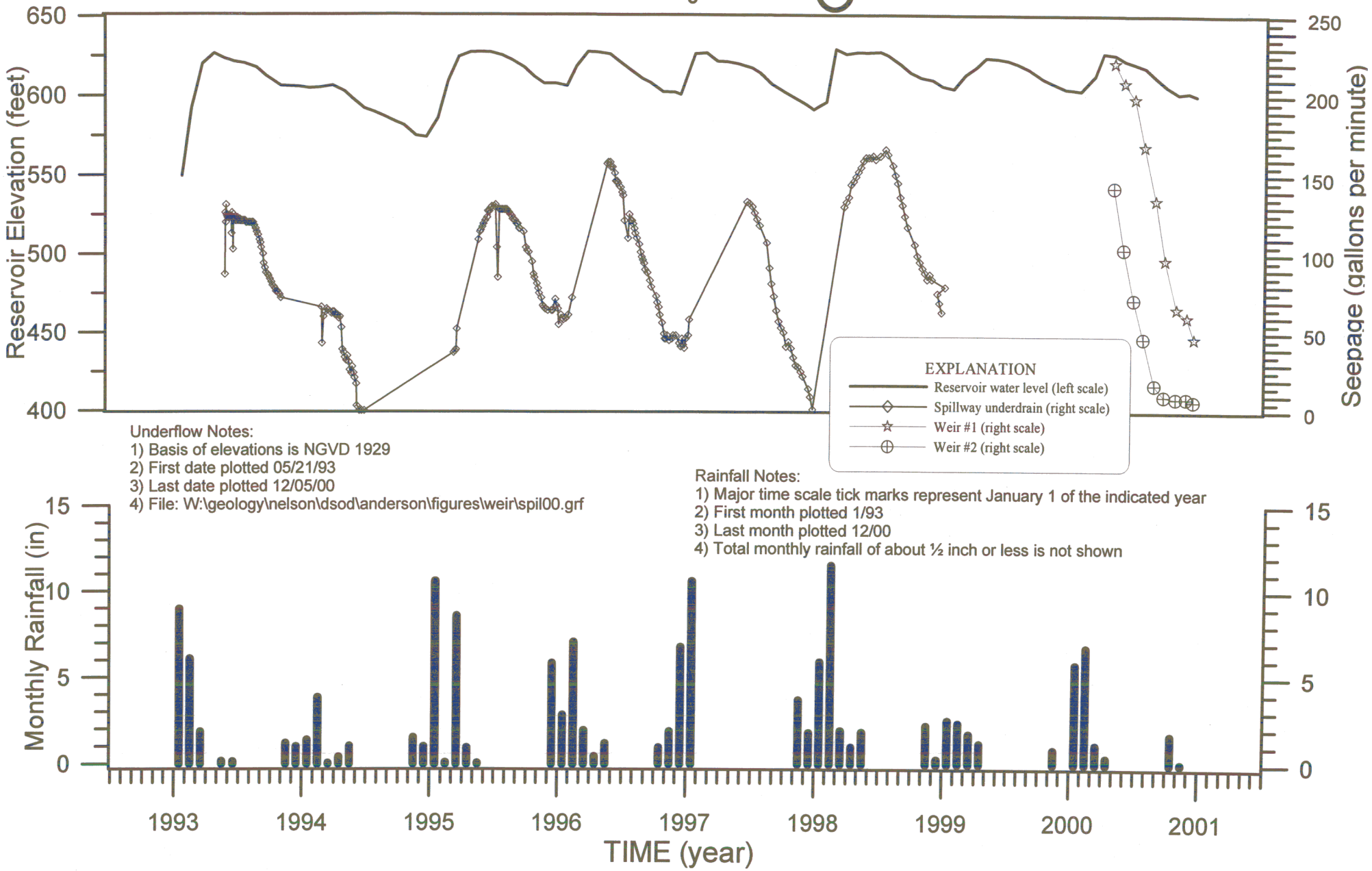
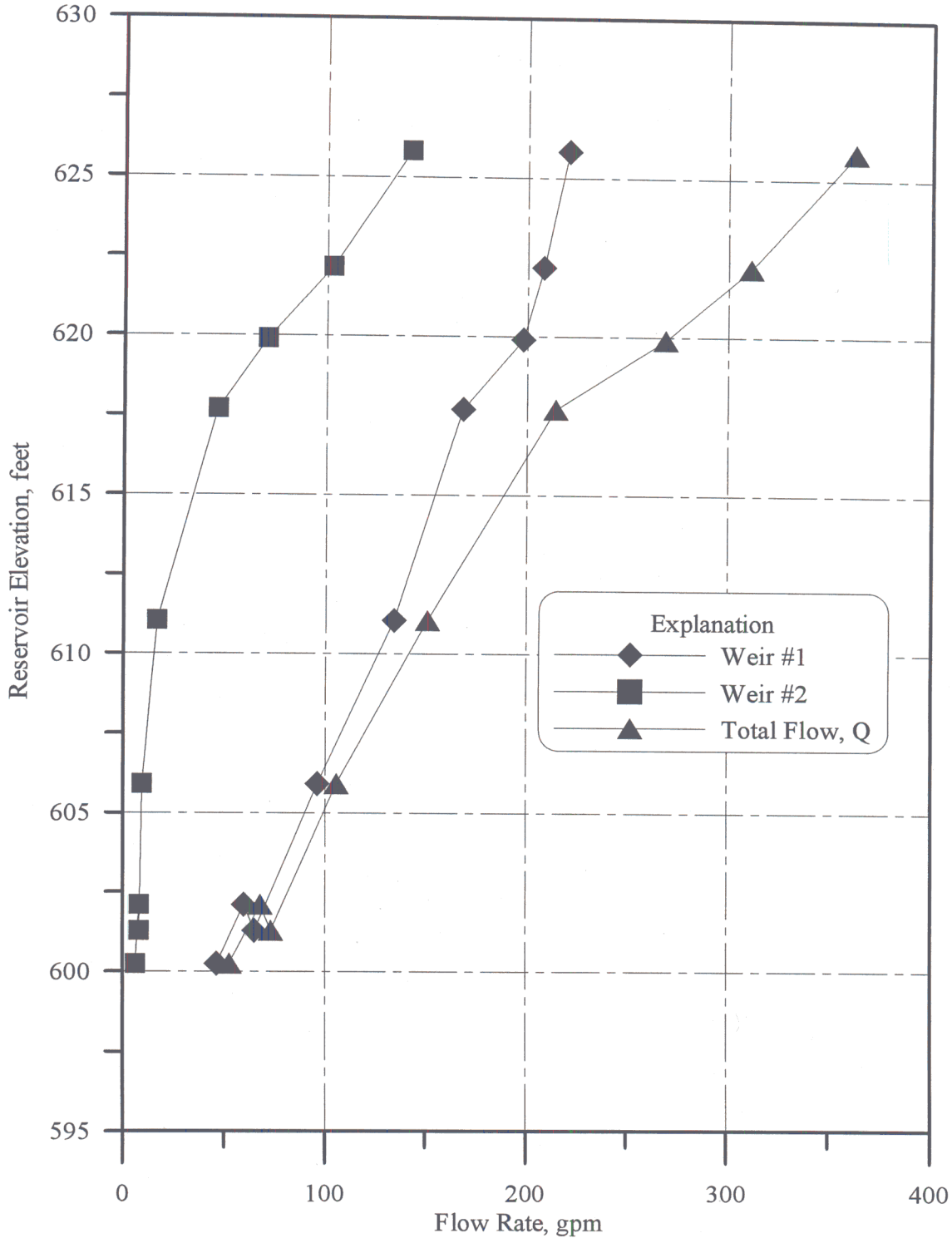


Figure 4. Reservoir Water Level, Historic Spillway Underdrain Flow/New Weir Flow, and Monthly Rainfall May 1993 to December 2000

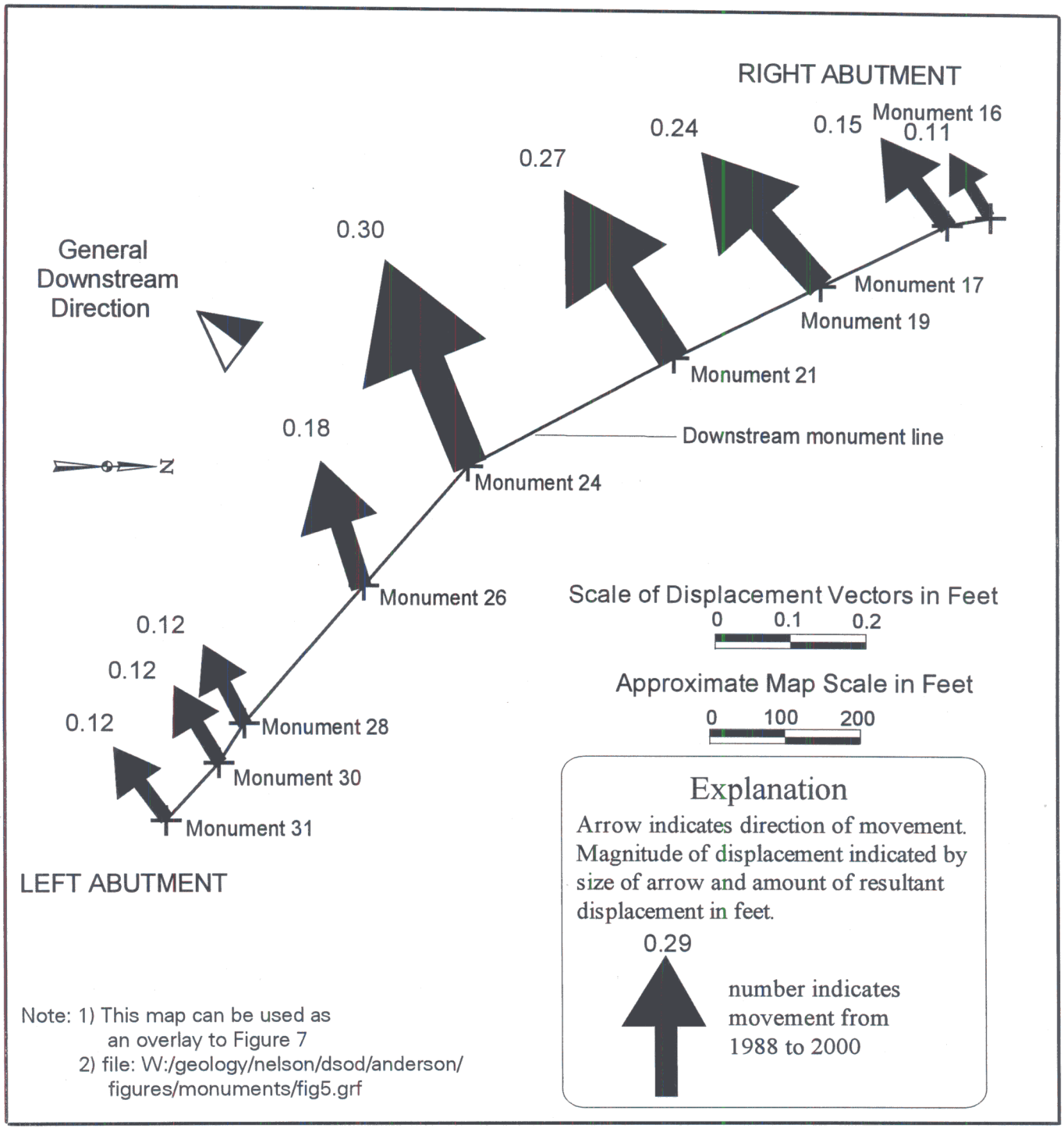


Notes: Weir No. 1 collects flow from the central portion of spillway
Weir No. 2 collects flow from the left side of spillway

DATE 2/21/01	Santa Clara Valley Water District	Spillway Seepage Weirs	SCALE as shown
DESIGN RLV		Leroy Anderson Dam (No. 72-9)	FIGURE 5
DRAWN JLN			
CHECKED RLV			

LEROY ANDERSON DAM (NO. 72-9)

Santa Clara Valley Water District



Note: Monuments 16 and 31 are centered on the crest and are included on all plots of downstream and upstream monuments.

Figure 6. Relative Displacement Vectors of Downstream Crest Monument Lateral Location Surveys, July 1988 through December 2000

LEROY ANDERSON DAM (NO. 72-9)

Santa Clara Valley Water District

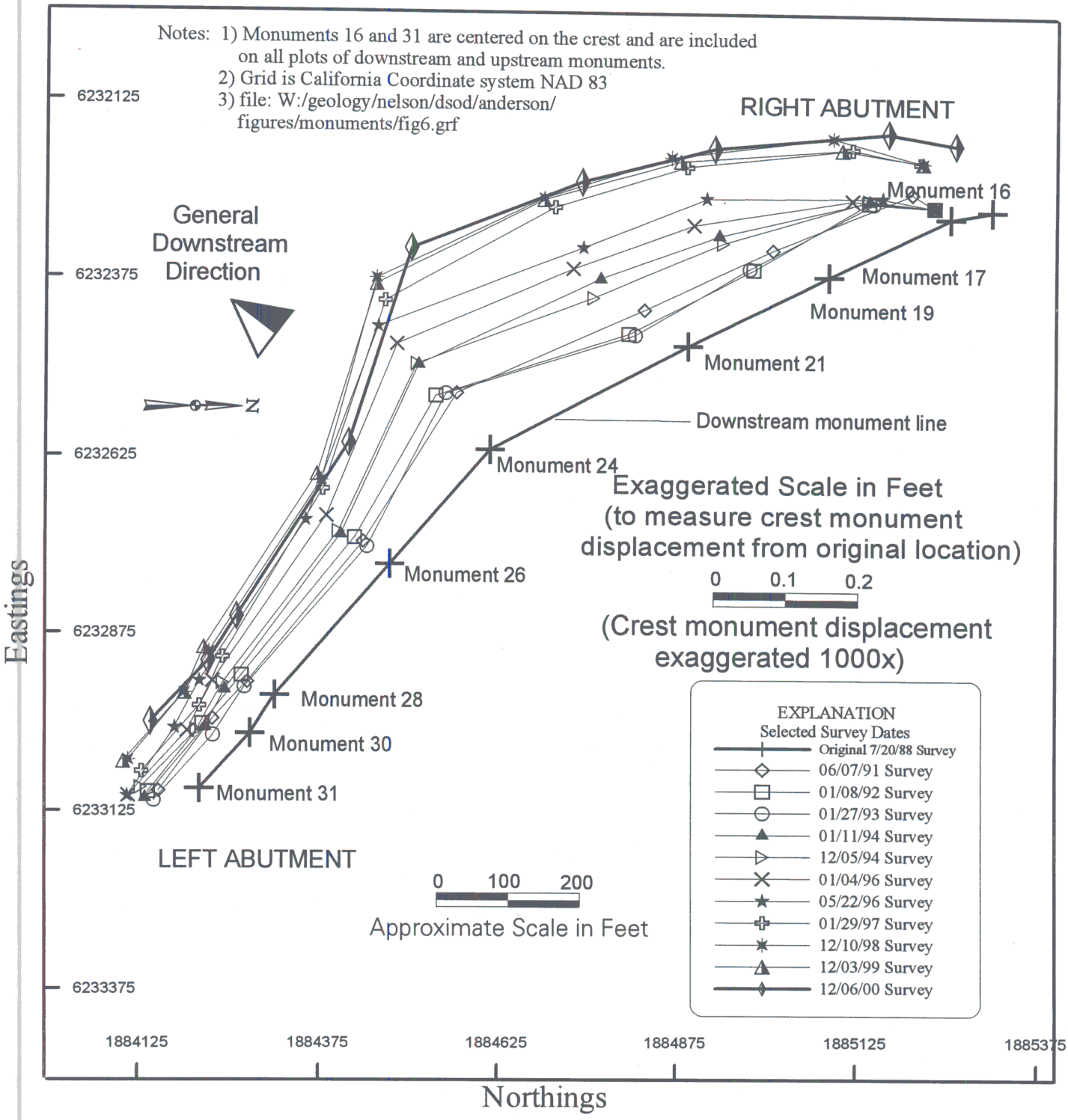
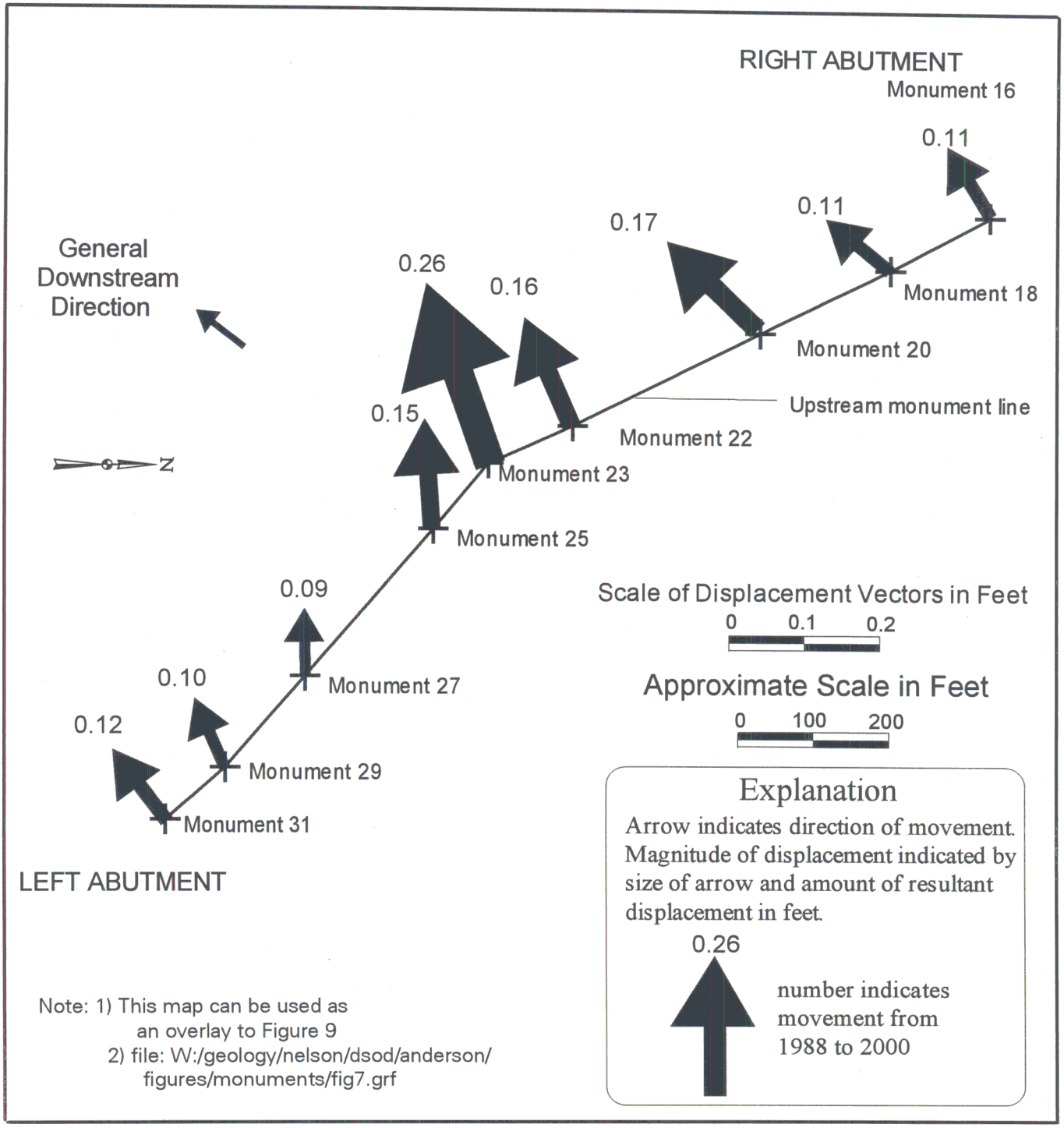


Figure 7. Downstream Crest Monument Lateral Location Surveys in Plan View, July 1988 through December 2000

LEROY ANDERSON DAM (NO. 72-9)

Santa Clara Valley Water District



Note: Monuments 16 and 31 are centered on the crest and are included on all plots of downstream and upstream monuments.

Figure 8. Relative Displacement Vectors of Upstream Crest Monument Lateral Location Surveys, July 1988 through December 2000

LEROY ANDERSON DAM (NO. 72-9)

Santa Clara Valley Water District

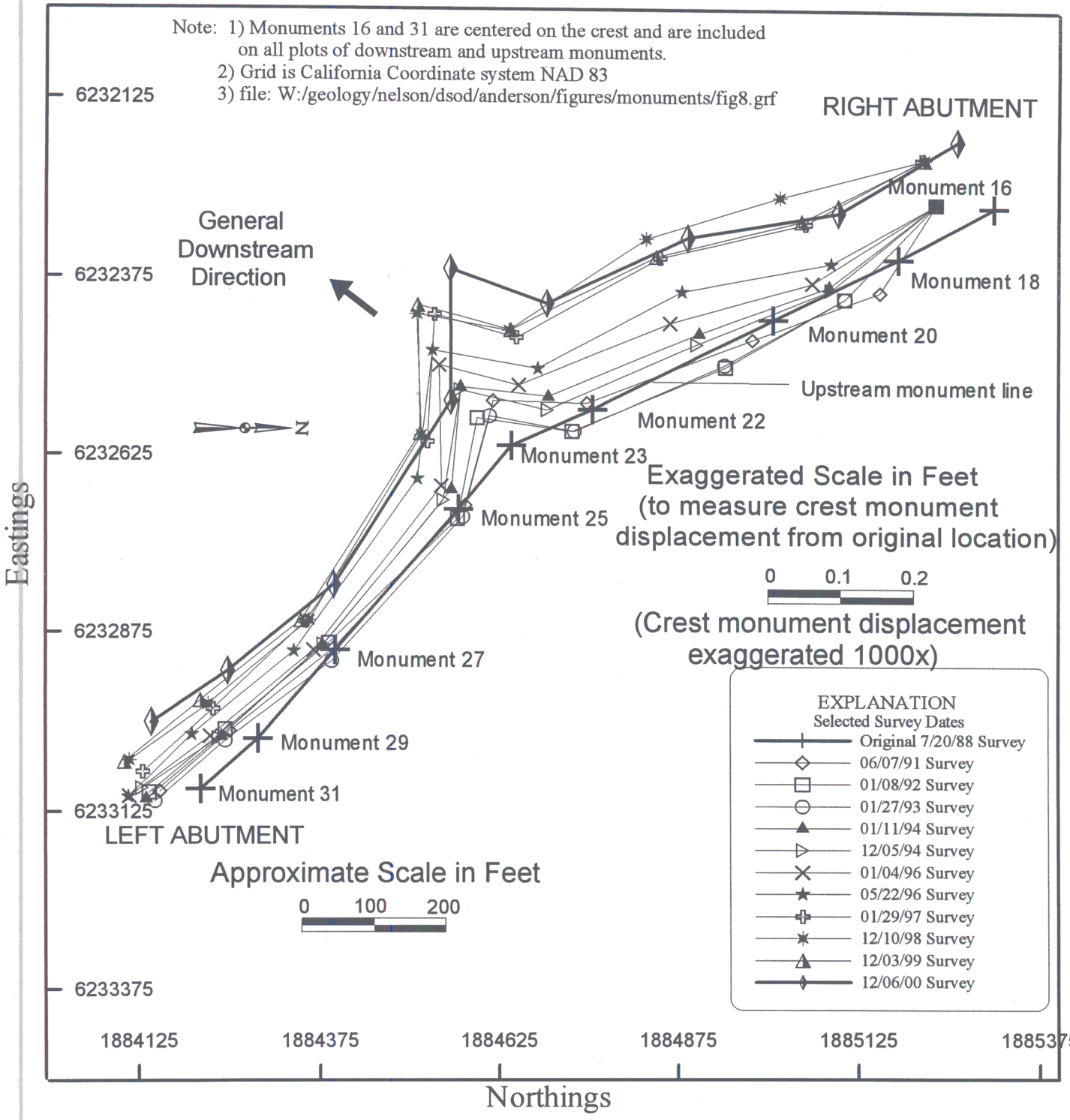


Figure 9. Upstream Crest Monument Lateral Location Surveys in Plan View, July 1988 through December 2000

LEROY ANDERSON DAM (NO. 72-9)

Santa Clara Valley Water District

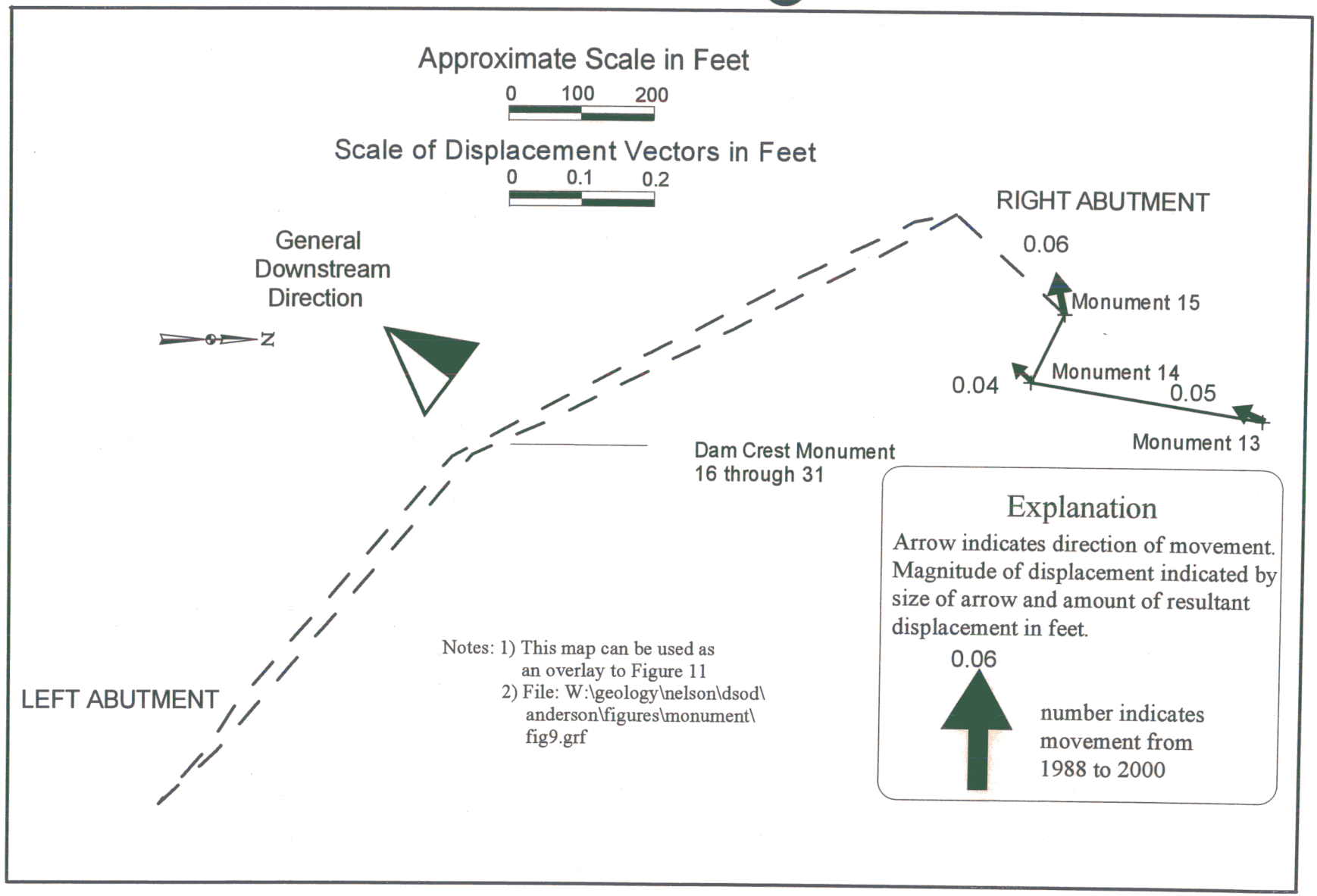


Figure 10. Relative Displacement Vectors of Spillway Training Wall Monument Lateral Location Surveys, July 1988 through December 2000

LEROY ANDERSON DAM (NO. 72-9)

Santa Clara Valley Water District

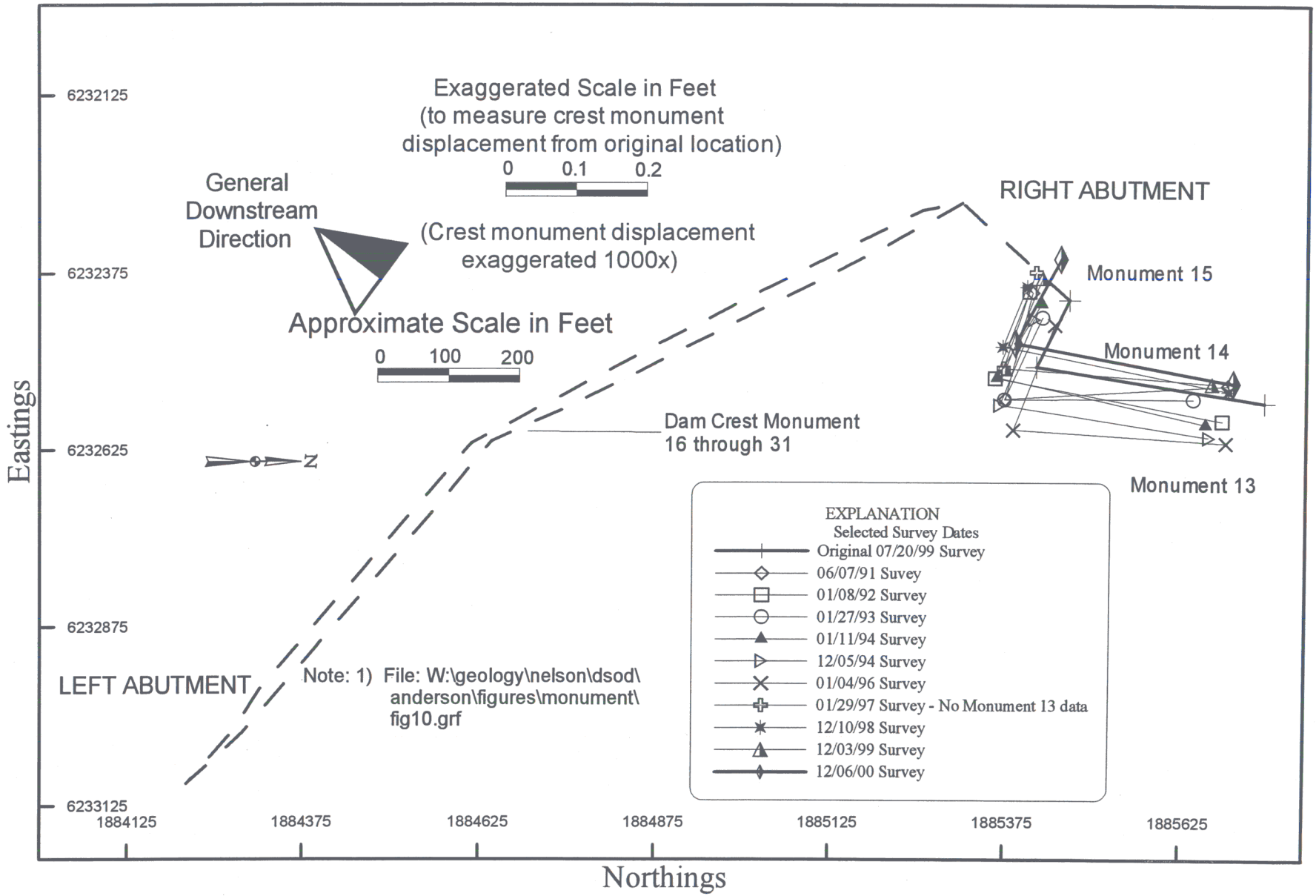


Figure 11. Spillway Training Wall Monument Lateral Location Surveys in Plan View, July 1988 through December 2000

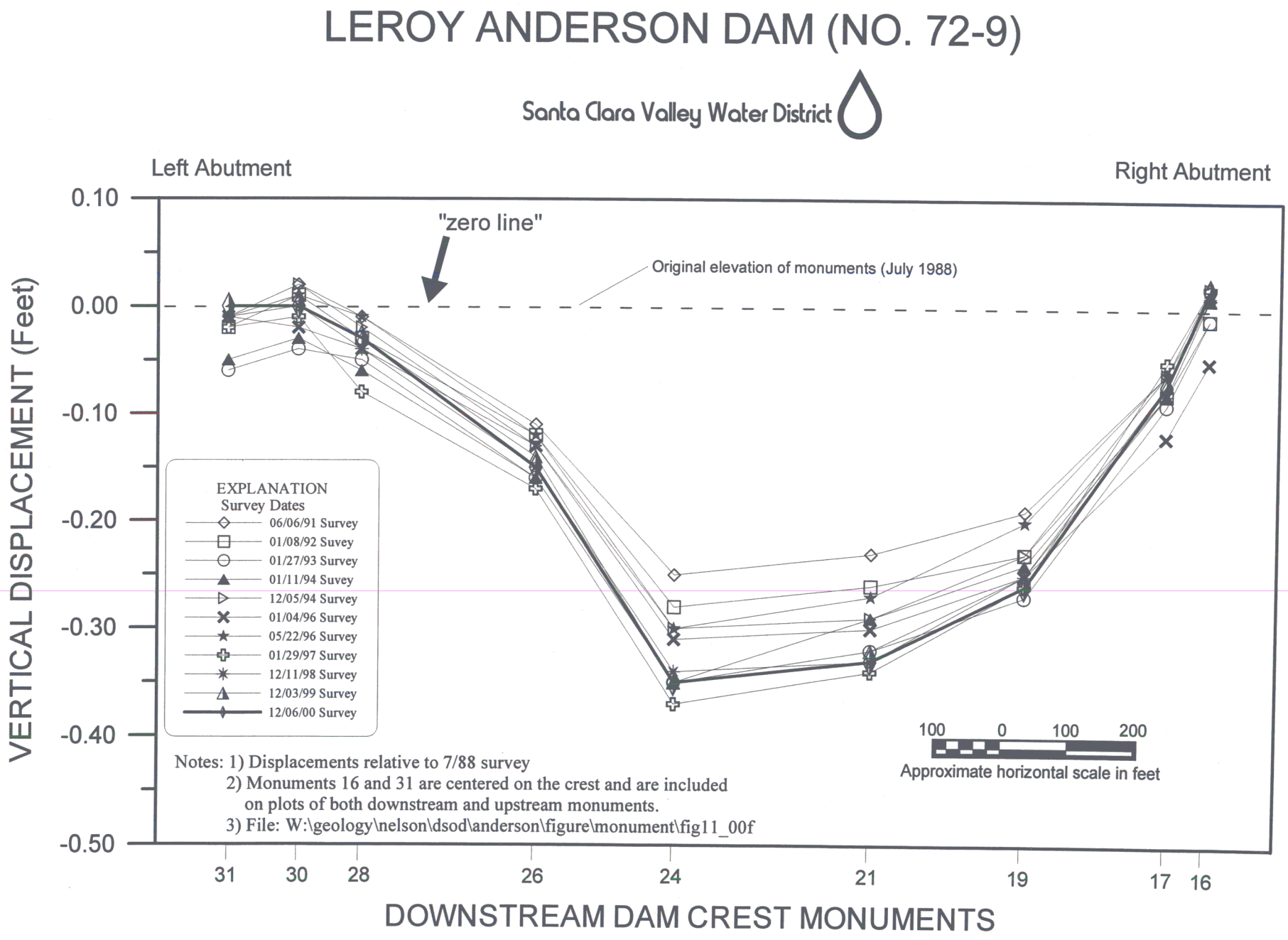


Figure 12. Downstream Crest Monument Vertical Location Surveys in Section View, July 1988 through December 2000

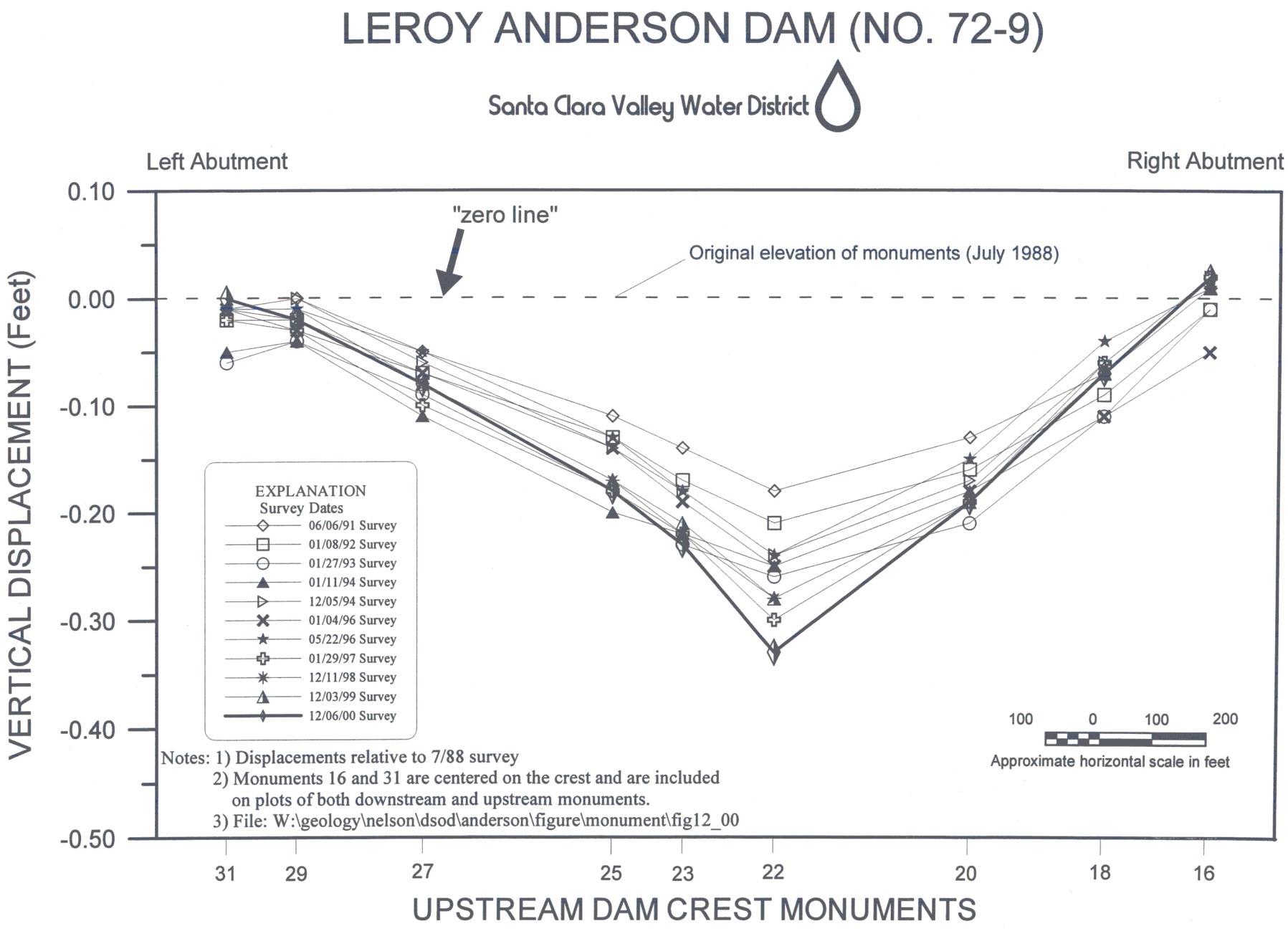


Figure 13. Upstream Crest Monument Vertical Location Surveys in Section View, July 1988 through December 2000

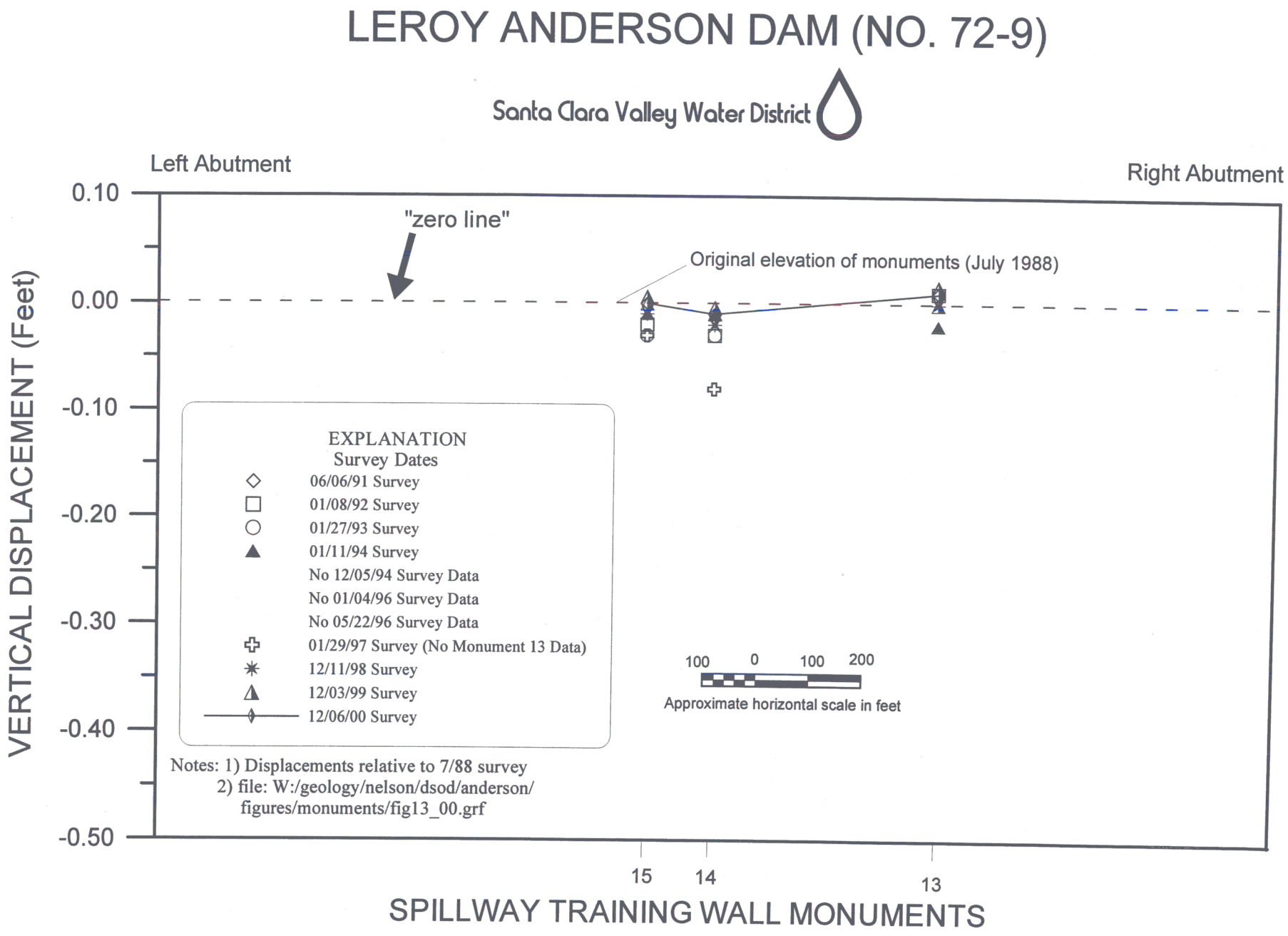


Figure 14. Spillway Training Wall Monument Vertical Location Surveys in Section View, July 1988 through December 2000

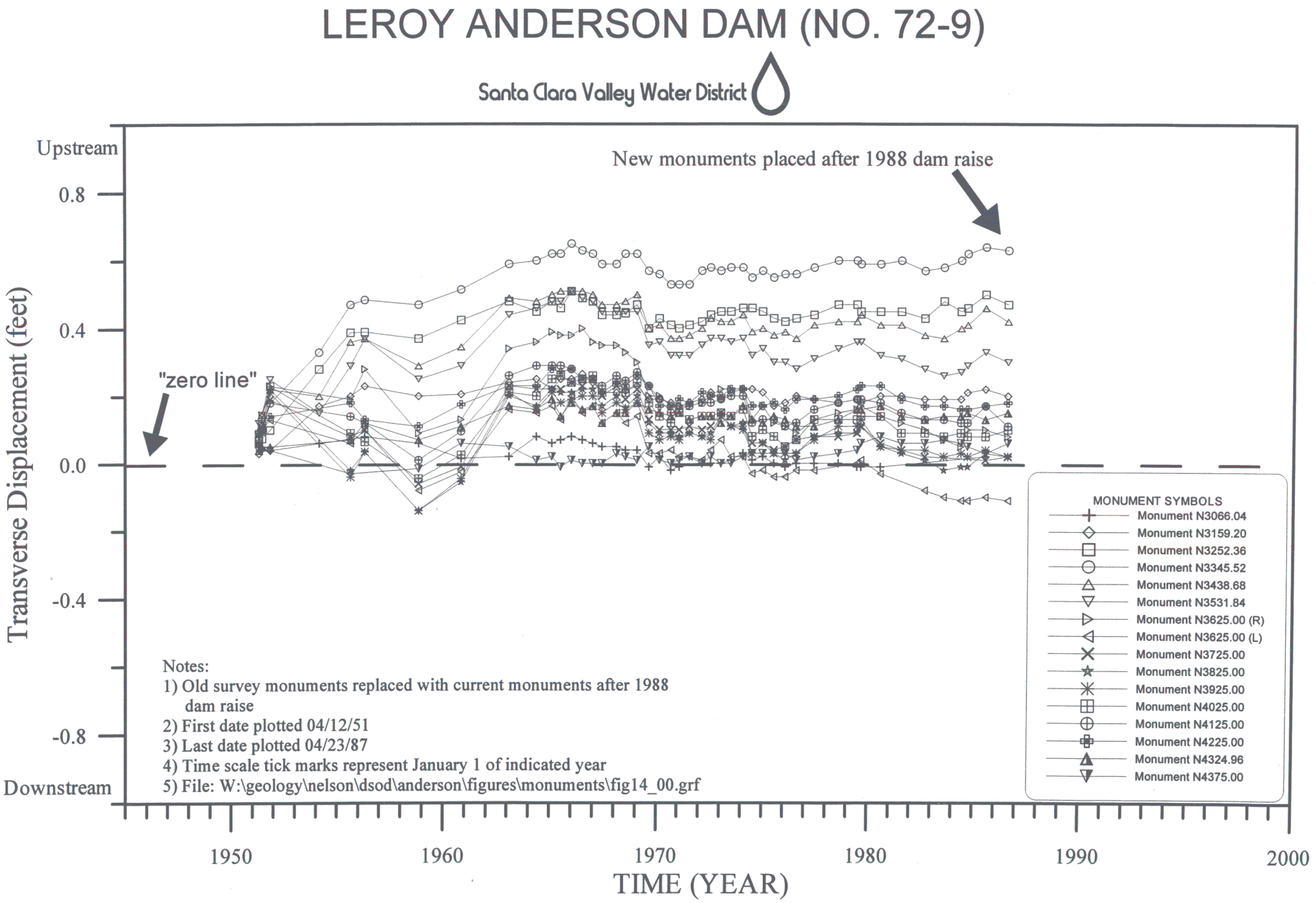


Figure 15. Original Crest Monument Transverse Displacement Versus Time, April 1951 through April 1987

LEROY ANDERSON DAM (N0. 72-9)

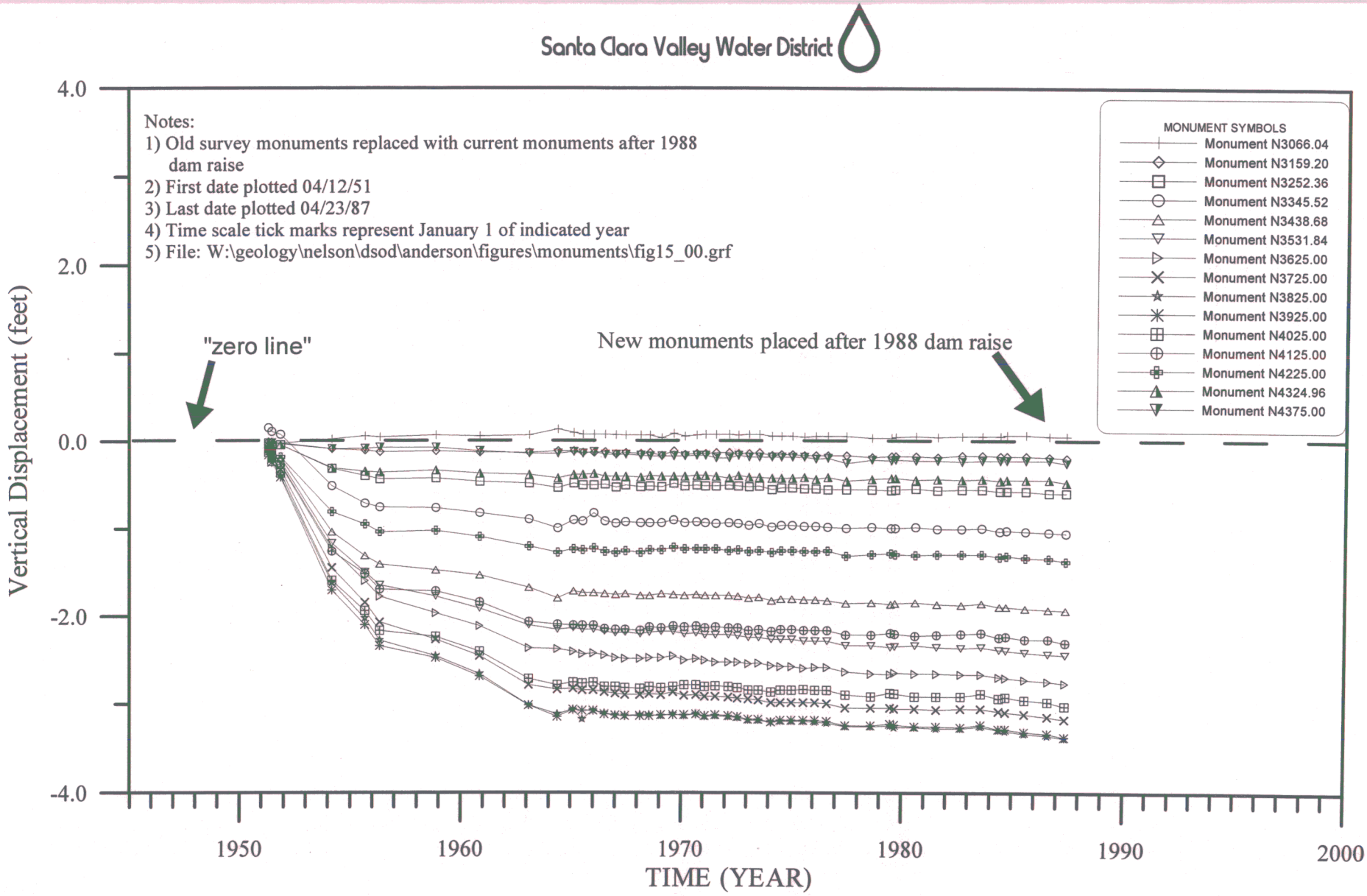


Figure 16. Original Crest Monument Vertical Displacement Versus Time, April 1951 through April 1987

LEROY ANDERSON DAM (NO. 72-9)

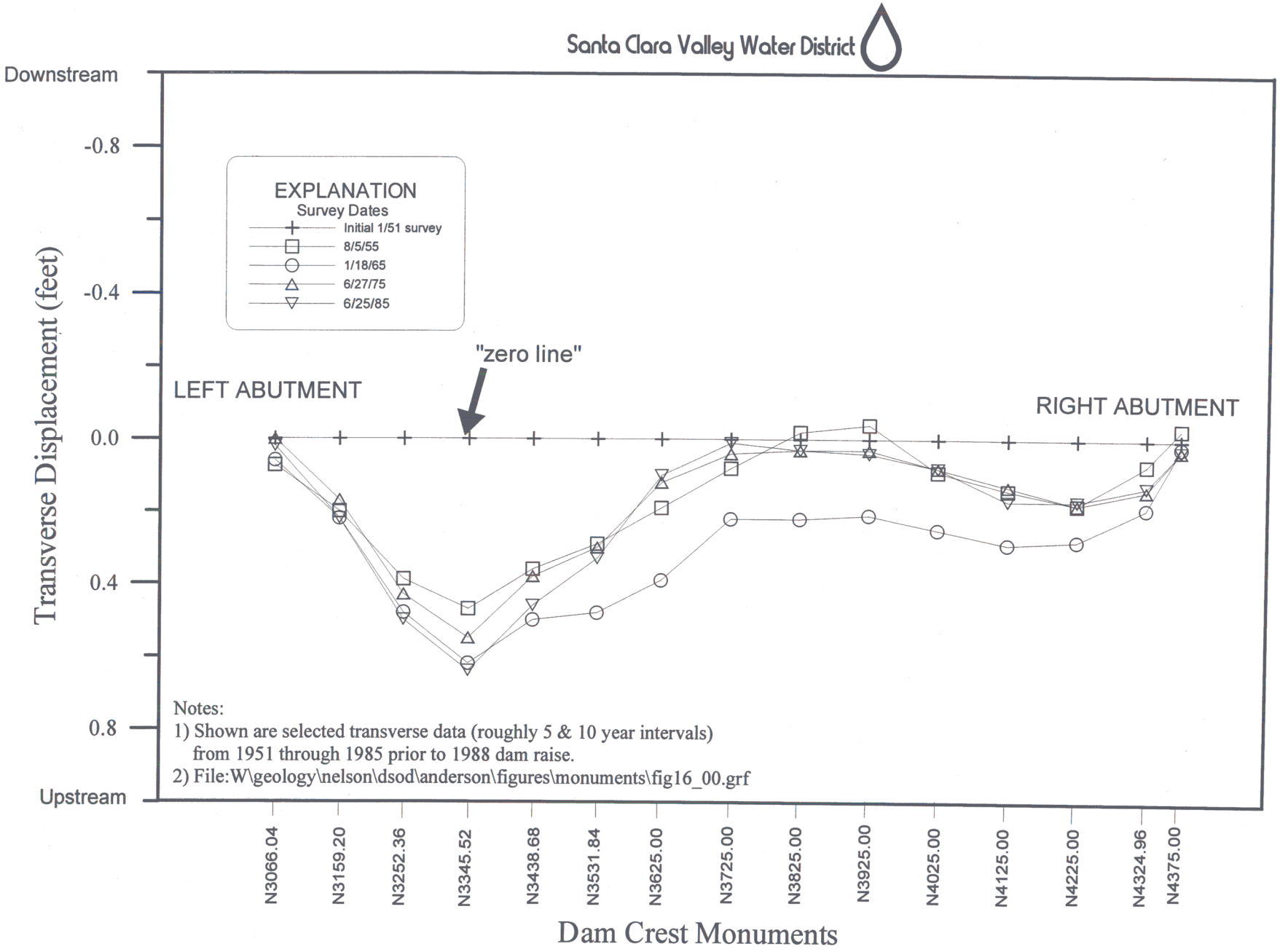


Figure 17. Selected Original Crest Monument Transverse Location Surveys in Plan View, January 1951 through June 1985

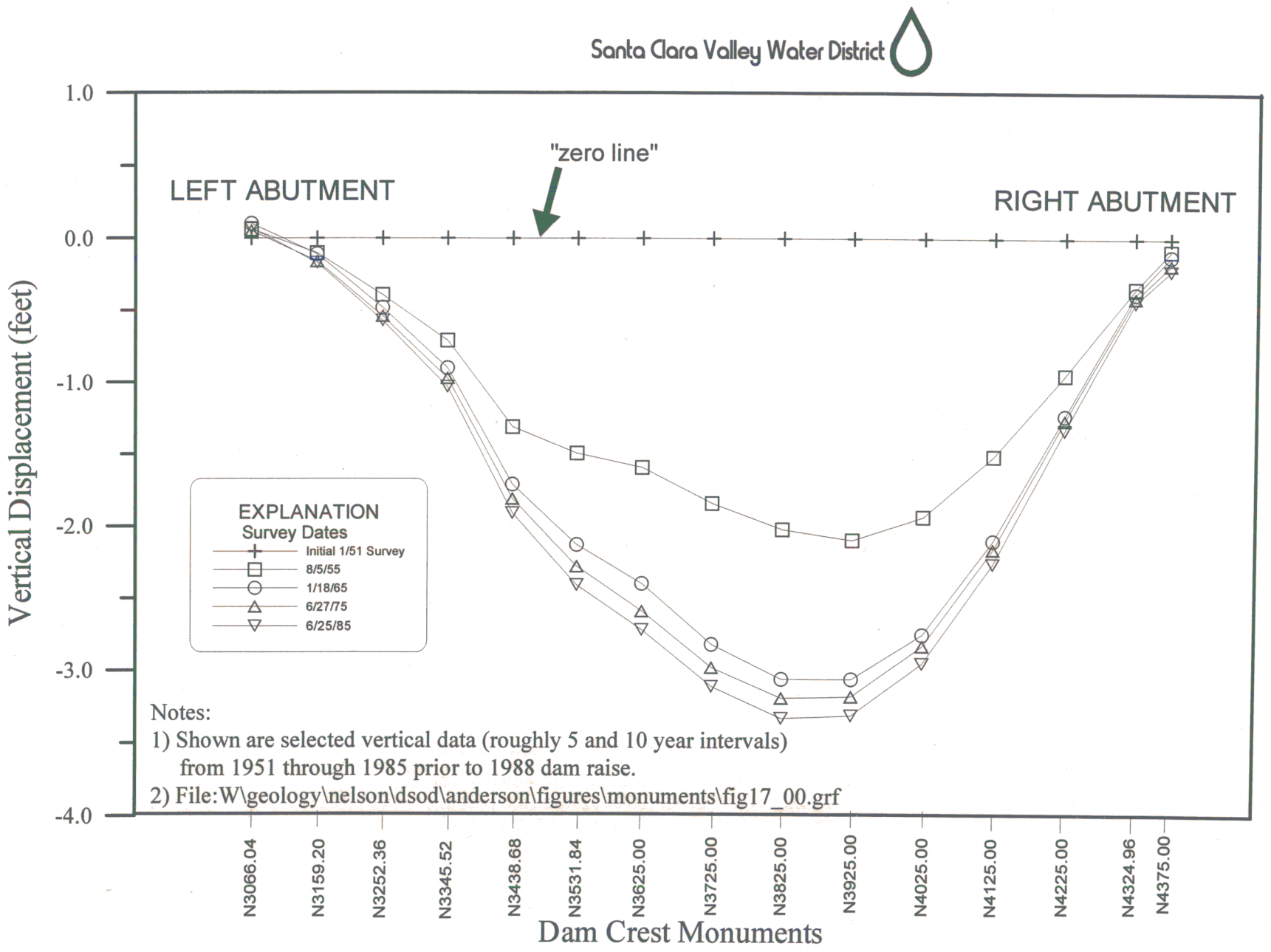


Figure 18. Selected Original Crest Monument Vertical Location Surveys in Section View, January 1951 through June 1985

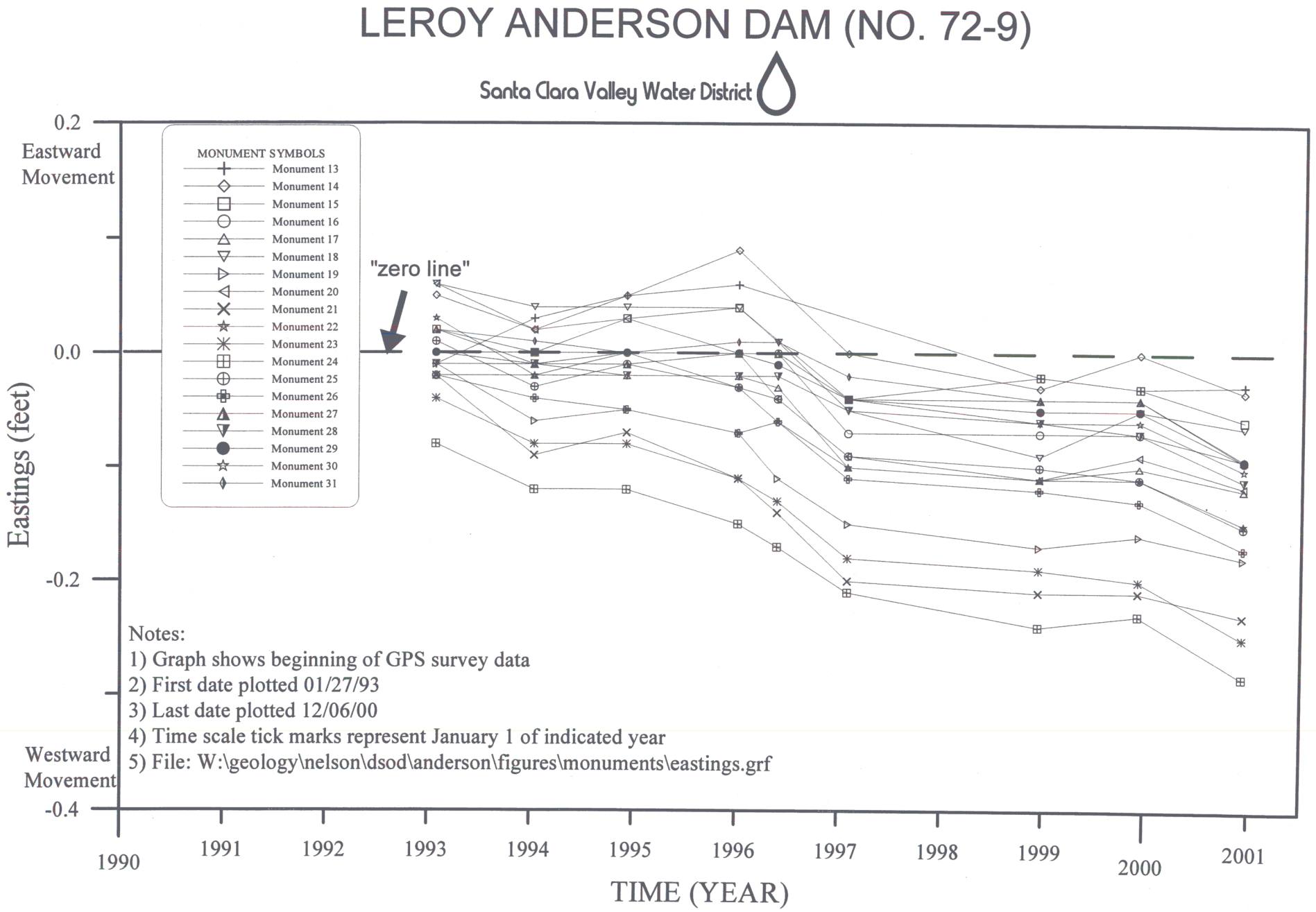


Figure 19. New Crest Monument Easting Displacement Versus Time, January 1993 through December 2000

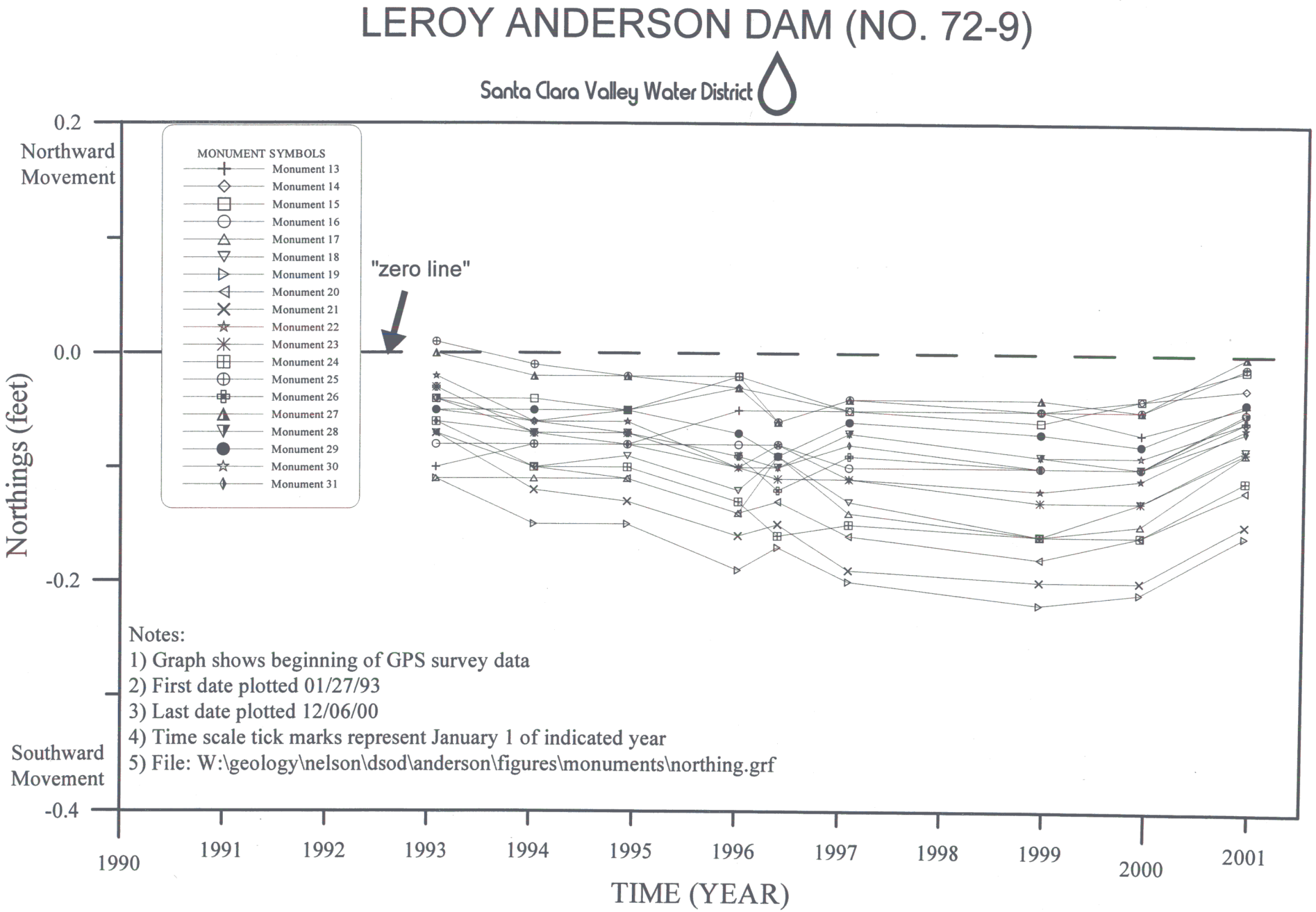
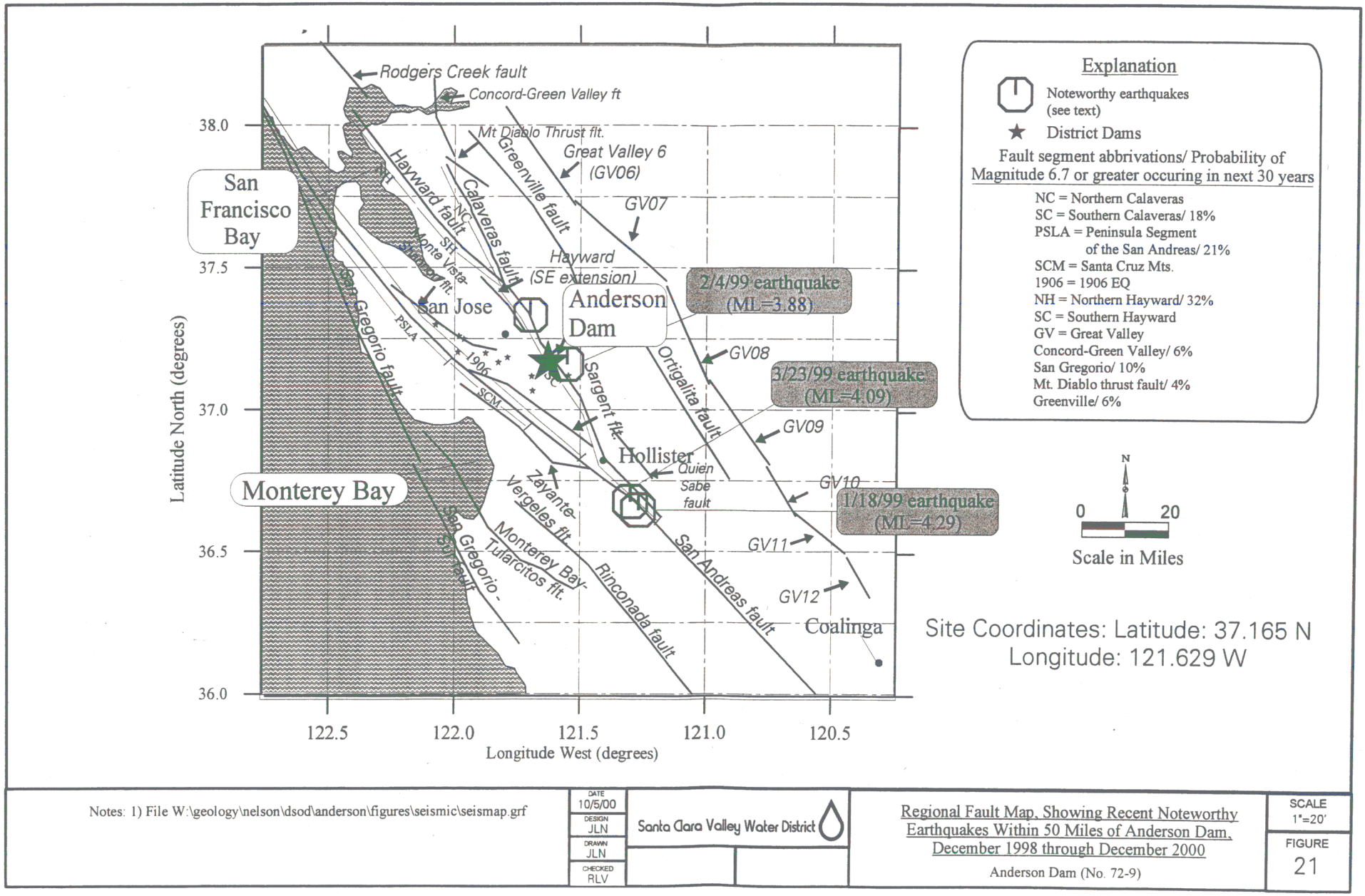


Figure 20. New Crest Monument Northing Displacement Versus Time, January 1993 through December 2000



Notes: 1) File W:\geology\nelson\dsod\anderson\figures\seismic\seismap.grf

DATE	10/5/00
DESIGN	JLN
DRAWN	JLN
CHECKED	RLV

Santa Clara Valley Water District

Regional Fault Map, Showing Recent Noteworthy Earthquakes Within 50 Miles of Anderson Dam, December 1998 through December 2000

Anderson Dam (No. 72-9)

SCALE 1"=20'

FIGURE 21